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FOURTH ANNUAL REPORT

OF THE

BOARD OF CONTROL

OF THE

STATE

AGRICULTURAL EXPERIMENT STATION,

AT

AMHERST, MASS.

1886.

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MASSACHUSETTS STATE

AGRICULTURAL EXPERIMENT STATION,

AT AMHERST, MASS.

BOARD OF CONTROL, 1886.

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DAVID WENTZELL, . . . *Farmer.*

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* Left July 1, 1886.

Boston, Jan. 11, 1887.

To the Honorable the Governor and Council, State of Massachusetts.

In accordance with the law of the State, I have the honor to present the Fourth Annual Report of the Board of Control of the State Agricultural Experiment Station.

ALVAN BARRUS,

Secretary.

FOURTH ANNUAL REPORT

OF THE

DIRECTOR OF THE STATE AGRICULTURAL EXPERIMENT STATION AT AMHERST, MASS.

To the Honorable Board of Control.

GENTLEMEN : — The past year has been one of marked activity in the history of the Station. The additional appropriation granted by the Legislature of 1886, for finishing and fitting up the chemical laboratory, has rendered it possible to finish the building, according to the design adopted by the Board, and to provide it with a gas machine, a heating apparatus, and such general appliances as are indispensable to meet the purpose for which it has been erected.

A new building has been added to those already existing for experiments in stock feeding. The structure is of wood ; clapboarded outside and sheathed inside ; fifty-six feet long, twenty-six feet wide, with posts twelve feet high. It is well lighted and ventilated, and contains six separate stalls for cows and two for horses.

The building for feeding experiments with pigs and sheep has been removed to a more convenient locality for the work carried on under its roof. This change in its position has rendered more compact the entire arrangements for keeping the various kinds of farm live-stock for feeding experiments, and will prove ultimately good economy in various directions.

A covered passage, seven feet wide and thirty feet long, has been built to connect the feed-room and its scales for weighing the daily fodder rations, by rails, with the stalls occupied by the animals on trial. The building, originally intended for heating apparatus and engine, has been enlarged nine feet in length and twelve feet in width, to serve in the near future for the management of the milk-setting apparatus.

The dwelling-house occupied by the farmer, as well as the principal barn and the sheds, have been kept in good repair. No alterations of any consequence have been made in these buildings. The contemplated changes are confined to the barn; they are of no particular importance as far as expenses are concerned, and may be attended to whenever circumstances render it advisable.

The entire expenses, arising from the increase and the improvement of farm buildings, have been paid from the regular annual income of the Station.

The work in the field has been on a more extensive scale than in any preceding year, for new lands have been added to those occupied during the past. The grounds assigned to the Station at the beginning of its existence consisted of two fields situated at some distance from each other. One field, about three acres in size, which had been used for a series of years for experiments with fruit, was returned three years ago to the College. The other, which comprises an area of 17.72 acres, has remained ever since under the control of the Station. Upon these grounds are located all buildings and experimental fields described in this and in the three preceding annual reports.

The new lands added during the past season, in consequence of an agreement between the Board of Trustees of the State Agricultural College and the Board of Control of the State Agricultural Experiment Station, consists of twenty acres of unimproved grass land and of about ten acres of wood-land. The entire field is a part of the western slope of a prominent and extended elevation, covered with a dense natural forest growth. The wood-land assigned to the Station stretches along the western termination of the grove; it reaches to the crest of the hill, and has been secured to enable the control of the water-shed towards the adjoining lower grounds. Three thousand and eight hundred feet of drain tiles have been laid to improve the growth on the lowlands. Twelve acres of the old grass land have been turned over to renovate the soil during the coming season by drill cultivation of suitable crops. It is proposed, subsequently, to turn the more elevated portion of these lands to account for experiments with fruit trees, and to raise upon

the remainder, according to particular location, either general farm crops, or utilize them as permanent meadows.

The area occupied by field experiments upon the old grounds has been considerably enlarged. The number of separate fields has been increased; their outlines have been established with a view to permanency, wherever the soil has attained a desirable uniformity as far as its state of cultivation, as well as the condition and character of its latent resources of plant food are concerned. To secure the latter condition as soon as practicable, one and the same mixture of manurial matter — ground bones and muriate of potash — has been used since the establishment of the Station, whenever a general good state of fertilization was needed in the interest of success. Four distinct fields, each more than one acre in size, have been thus far set off to serve, if necessary, for years, for some definite line of observations. The experimental work carried on in the barn, the field and the laboratory during the past year is described in the subsequent pages under the following headings: —

1. Experiments with milch cows to ascertain the feeding value of corn stover as a substitute for English hay, and that of corn ensilage as compared with beet roots.

2. Analyses of fodder articles with reference to their nutritive value, accompanied by a short exposition of the leading principles recognized as the basis for determining the comparative feeding value of our fodder articles in a rational system of stock feeding.

3. Analyses of some prominent feed stuffs, with reference to the fertilizing constituents they contain.

4. On the best condition of fodder corn for the silo.

5. Fodder corn raised on underdrained and exhausted lands, partly manured with one single article of plant food, partly without the use of any manurial matter.

6. Influence of fertilizers on the quantity and the quality of some prominent crops, — corn and four grasses.

7. Experiments with some prominent fodder crops to furnish a continuous supply of green fodder for dairy stock, — oats, vetch, serradella and Southern pea vines.

8. Experiments with potatoes.

9. Miscellaneous field experiments.

10. Fertilizers and fertilizer analyses; miscellaneous analyses.

11. Well water analyses.

12. Meteorological observations.

It may be noticed from the above statement that some of the reported experiments are continuations of inquiries inaugurated in previous years, while others are the natural outgrowths of preceding investigations; some open new lines of observation.

Considerable attention has been devoted during the past year to constructing buildings, providing a better outfit for the chemical laboratory and for the stock-feeding department. The new year cannot otherwise but materially benefit from the change. The periodical publications of the Station have not been as numerous during the preceding year, on account of temporary interruptions in the work in consequence of delays caused by the erection of new buildings and the remodelling of old ones. The interest in the bulletins and annual reports has been steadily increasing throughout all parts of the State and elsewhere. The printing of bulletins has been increased from three thousand five hundred in 1885, to five thousand copies each in 1886. The second annual report is entirely out of print, and but few of the first and third reports are still at our disposal. None of the bulletins, Nos. 1 to 16, are on hand; the same is the case with No. 20 of the last year. The publication will be resumed at an early date.

The support received from all parties connected with the work of the Station has been very satisfactory.

Permit me to thank you sincerely for the hearty encouragement and the kind support I have enjoyed in carrying on the work assigned to me.

Yours very respectfully,

C. A. GOESSMANN,
Director of the State Agricultural Experiment Station.

FEEDING EXPERIMENTS.

C. A. GOESSMANN.

1. Experiments with Milch Cows.

The feeding experiments described within a few subsequent pages were chiefly instituted for the purpose of studying the feeding value of dried corn fodder (stover) as a substitute for English hay, and of beet roots as compared with corn ensilage. The observations made in this connection extended over a period of nearly eight months, — November, 1885, to July, 1886.

Two cows, crosses of native stock and Ayrshires, and both from six to seven years old, served for the trial. They were in the same milking period, four weeks after calving, at the beginning of the experiments. The changes in diet, whenever decided upon, were made gradual, to prevent any serious disturbance in the general condition of the animal on trial. As a rule, from four to five or more days were allowed to pass by, in case of a change of food, before a record of the daily yield of milk was made for the purpose of comparing the effect of different fodder rations.

The valuation of the various fodder articles consumed is based on our local market prices, per ton, at the time of their use: Good English hay, $15; corn meal, $23; wheat bran, $20; dry corn fodder (stover), $5; corn ensilage, $2.75; Lane's Improved Sugar Beet, $5.

The daily diet of both cows consisted at the beginning of the experiments of three and one-quarter pounds of corn meal, an equal weight of wheat bran and all the hay they would eat.

The actual amount of hay consumed, in each case, was ascertained by weighing out daily a liberal supply of it and deducting subsequently the hay left over. The same fodder mixture, as far as quality and quantity are concerned, was also used for some time as daily feed at the close of the experiment. This course was adopted for the purpose of ascertaining the natural shrinkage in daily yield of milk during the time engaged by the experiments (from seven to eight months). It amounted, as may be noticed in the subsequent detailed record, to nearly 50 per cent. of the original yield of milk.

The above-stated combination of fodder articles was adopted as the basis of our investigation, mainly for the reason that it had been used with satisfactory results in some of our earlier feeding experiments, and not on the assumption of its being the best possible combination of fodder articles for milch cows.

The value of a fodder for dairy purposes may be stated from two distinctly different standpoints, — namely, with reference to its influence on the temporary yield of milk, and the general condition of the animals which consume it; and in regard to its first cost, *i. e.*, its physiological and its commercial value.

The market price of our fodder articles depends on the supply and demand in the general market; its determination is beyond the control of the individual farmer. The market price of hay of the same quality may vary widely in different years and in different localities; its feeding value remains materially the same, under corresponding circumstances, year after year.

The market value and actual feeding effect of one and the same article do not necessarily correspond with each other; in fact, they rarely coincide.

The market value may be stated for each locality by one definite number. *The feeding effect* of one and the same substance, simple or compound, varies under different circumstances, and depends in a controlling degree on its judicious use. Sugar fed without any suitable admixture has no feeding value; it is worthless as the sole food of an animal. Properly supplemented,— as, for instance, in the sweet corn,— its nutritive value is very great. Bread has a high feeding value for man; a cat fed exclusively with bread dies, after some weeks, with the symptoms of starvation.

As no single plant or part of plant has been found to supply economically and efficiently to any considerable extent the wants of our various kinds of farm stock, it becomes a matter of first importance to learn how to *supplement* our leading farm crops, to meet the divers wants of each kind. To secure the highest feeding value of each article of fodder is most desirable in the interest of good economy. The judicious selection of ingredients for a suitable and remunerative diet for our dairy stock obliges us, therefore, to study the value of the fodder articles at our disposal from both standpoints.

The chemical analyses of the various articles used in the combination of fodder in our case, are stated in some succeeding pages to show their character and their respective quality. To ascertain the chemical composition of a fodder ration in connection with an otherwise carefully managed feeding experiment, enables us to recognize, with more certainty, the causes of the varying feeding effects of one and the same fodder article, when fed in different combinations. It furnishes also a most valuable guide in the selection of suitable commercial feed stuffs from *known sources* to supplement economically our home-raised fodder crops. Practical experience in feeding stock has so far advanced, that it seems to need no further argument to accept it as a matter of fact, that the efficiency of a fodder ration in the dairy does not depend on the mere presence of more or less of certain prominent fodder articles, but on the presence of a proper quantity and a certain relative proportion of some prominent constituents of plants, which are known to be essential for a successful support of life and the special functions of the dairy cow.

Investigations into the relations which the various prominent constituents of plants bear to the support of animal life, have rendered it advisable to classify them in this connection into three groups,—mineral constituents, and nitrogenous and non-nitrogenous organic constituents. For details regarding this matter I have to refer to previous publications of the Station. Numerous and extensive practical feeding experiments, with most of our prominent fodder articles in various conditions, and with all kinds of farm live stock, have introduced the practice of reporting together with analysis of the chemist, the

results of careful feeding experiments, as far as the various fodder articles have proved digestible, and were thus qualified for the support of the life and the functions of the particular kind of animal on trial. In stating the amount of the digestible portion of the fodder consumed in a feeding experiment, it has also proved useful for comparing different fodder rations, etc., to make known by a distinct record the relative proportion which has been noticed to exist, between the amount of nitrogenous constituents and the non-nitrogenous organic constituents. This relation is expressed by the name of "Nutritive Ratio." An examination of the subsequent short description of our feeding experiments will show, for instance, that the corn meal we fed contained one part of digestible nitrogenous matter, to 8.76 parts of digestible non-nitrogenous organic matter, making the customary allowance for the higher physiological value of the fat as compared with that of starch, sugar, etc. (2.5 times higher). The "Nutritive Ratio" of the corn meal is subsequently stated as follows 1 : 8.76. Our different combinations of fodder articles, to constitute the daily diet during different feeding periods, vary as far as their nutritive ratios are concerned from 1 : 6.7 to 1 : 10.17. The closer relation (1 : 6.7) was obtained by an exceptionally large amount of roots, with hay and wheat bran without corn meal; and the wider relation (1 : 10.17), by feeding a liberal amount of corn ensilage with hay and corn meal without bran. A closer relation of nitrogenous and non-nitrogenous digestible constituents of an otherwise suitable fodder mixture is considered more necessary for growing animals and dairy cows, than for full-grown animals and moderately worked horses and oxen. German investigators recommend for dairy cows a diet which conforms to a nutritive ratio of 1 : 5.4. Arrangements will be made during the coming winter season to repeat our feeding experiments with essentially the same coarse fodder articles, but modified by a suitable increase and addition of concentrated feed stuffs to secure daily diet of a closer nutritive ratio, than has been used on the present occasion.

An examination of the subsequent tabulated statement of the results of our experiments shows, among other interesting facts, the marked influence of the feeding of dried corn fodder and of

corn ensilage as a substitute for a part of the English hay, on the cost of the production of milk. Not less striking is the beneficial influence of a moderate amount of roots, as a substitude for a part of the hay, on the quality of milk. A numerical expression of the influence of the yield of milk in case of different cows, as well as at different milking periods of the same cow under the same system of feeding, on the cost of its production, may not be without some interest, when entering upon a serious discussion of the question, What kind of cows ought to be removed from our dairy stock in the interest of good economy?

Record of Daisy.

Feeding Periods.	Feed Consumed (lbs.) per day.						Amount of dry vegetable matter contained in the daily fodder consumed (in pounds).	Quarts of milk produced per day.	Pounds of dry matter per quart of milk.	Nutritive Ratio.	Weight of Animal.
	Wheat Shorts.	Corn Meal.	Corn Fodder.	Hay.	Ensilage.	Roots.					
1885. Nov. 20 to Dec. 7, .	3.25	3.25	–	20.00	–	–	24.06	16.3	1.48	1: 8.2	910
Dec. 19 to 29, .	3.25	3.25	8.00	10.00	–	–	21.64	15.4	1.45	1: 7.9	895
1886. Jan. 3 to 22, .	3.25	3.25	12.00	5.00	–	–	20.44	14.2	1.44	1: 7.72	850
Feb. 1 to 17, .	3.25	3.25	–	15.00	–	27.00	23.91	14.2	1.68	1: 7.1	845
" 20 to 28, .	3.25	–	–	15.00	–	27.00	21.06	13.2	1.60	1: 6.9	850
Mar. 1 to 8, .	3.25	–	–	15.00	–	40.00	23.18	13.3	1.74	1: 6.7	873
" 12 to 22, .	3.25	3.25	–	15.00	–	27.00	23.89	14.2	1.68	1: 7.1	860
" 25 to Apr. 13,	3.25	3 25	–	14.60	20.63	–	23.73	12.8	1.85	1: 8.14	870
Apr. 18 to May 6,	3.25	3.25	–	10.00	29.71	–	21.51	11.0	1.91	1: 8.15	865
May 20 to 31, .	–	3.25	–	5.00	41.75	–	16.83	9.2	1.83	1:10.17	830
June 4 to 14, .	3.25	–	–	5.00	41.36	–	16.76	8.9	1.88	1: 8.29	855
" 26 to July 4,	3.25	3.25	–	20.00	–	–	24.04	8.4	2.86	1: 8.2	840

Record of Mollie.

Feeding Periods.	Feed Consumed (lbs.) per day.						Amount of dry vegetable matter contained in the daily fodder consumed (in pounds).	Quarts of milk produced per day.	Pounds of dry matter per quart of milk.	Nutritive Ratio.	Weight of Animal.
	Wheat Shorts.	Corn Meal.	Corn Fodder.	Hay.	Ensilage.	Roots.					
1885. Nov. 20 to Dec. 7,	3.25	3.25	–	20.00	–	–	24.06	12.62	1 93	1: 8.2	882
Dec. 19 to 29, .	3.25	3.25	8.00	10.00	–	–	21.64	11.86	1.82	1: 7.9	885
1886. Jan. 3 to 22, .	3.25	3.25	13.35	5.00	–	–	21.75	13.87	1.56	1: 7.87	845
Feb. 1 to 17, .	3.25	3.25	–	15.00	–	27.00	23 91	11.16	2.14	1: 7.1	868
" 17 to 28, .	3.25	–	–	15.00	–	27.00	21.06	13.2	1.60	1: 6.9	910
Mar. 1 to 8, .	3.25	–	–	15.00	–	40.00	23.18	10.6	2.19	1: 6.7	895
" 12 to 22, .	3.25	3.25	–	15.00	–	27.00	23 89	11.1	2 15	1: 7.1	905
" 25 to Apr. 13,	3.25	3.25	–	14.20	22.27	–	23.74	11.2	2.12	1: 8.17	921
Apr. 18 to May 6,	3.25	3.25	–	10.00	29.82	–	21.58	10.6	2.04	1: 8.15	899
May 20 to 31, .	–	3.25	–	5.00	36.83	–	16 64	8.9	1.87	1:10.09	850
June 4 to 14, .	3.25	–	–	5.00	40.63	–	16.59	9.1	1 82	1: 8.25	852
" 26 to July 4,	3.25	3.25	–	20.00	–	–	24.04	8.6	2.80	1: 8.2	830

Cost of Feed Per Quart of Milk.

(DAISY.)

FEEDING PERIODS.	Total Quantity of Milk Produced during Entire Period.	Average Daily Yield of Milk for Period.	Total Amount of Shorts Consumed during Period.	Total Amount of Corn Meal Consumed during Period.	Total Amount of Corn Fodder Consumed during Period.	Total Amount of Hay Consumed during Period	Total Amount of Ensilage Consumed during Period.	Total Amount of Roots Consumed during Period.	Total Cost of Fodder Consumed during Period.	Average Cost of Feed for Production of One Quart of Milk for Period.
	Qts.	*Qts.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		*Cents.*
Nov. 20 to Dec. 7,	292.5	16.3	58.50	58.50	–	360.00	–	–	$3.96	1.35
Dec. 19 to 29, .	169.0	15.4	35.75	35.75	88.00	110.00	–	–	1.81	1.07
Jan. 3 to 22, .	283.5	14.2	65.00	65.00	240 00	100.00	–	–	2.75	0.97
Feb. 1 to 17, .	241.5	14.2	55.25	55.25	–	255.00	–	459.00	4.25	1.76
" 20 to 28, .	118.5	13.2	29.25	–	–	135.00	–	243.00	1.91	1.61
Mar. 1 to 8, .	106.5	13.3	26.00	–	–	120.00	–	320.00	1.96	1.84
" 12 to 22, .	156.5	14 2	35.75	35.75	–	165.00	–	297.00	2.75	1.76
" 25 to Apr. 13,	256.2	12.8	65.00	65.00	–	292.00	412.50	–	4.12	1.61
Apr. 18 to May 6,	209.5	11.6	61.75	61.75	–	190.00	564.50	–	3.49	1.67
May 20 to 31, .	112.7	9.2	–	39.00	–	60.00	501.00	–	1 55	1.37
June 4 to 14, .	98.0	8.9	35.75	–	–	55.00	455.00	–	1.36	1.39
" 26 to July 4,	75.5	8.4	29.25	29.25	–	180.00	–	–	1.99	2.64

Cost of Feed per Quart of Milk.

(MOLLIE.)

FEEDING PERIODS.	Total Quantity of Milk Produced during Entire Period.	Average Daily Yield of Milk for Period.	Total Amount of Shorts Consumed during Period.	Total Amount of Corn Meal Consumed during Period.	Total Amount of Fodder Corn Consumed during Period.	Total Amount of Hay Consumed during Period.	Total Amount of Ensilage Consumed during Period.	Total Amount of Roots Consumed during Period.	Total Cost of Fodder Consumed during Period.	Average Cost of Feed for Production of One Quart of Milk for Period.
	Qts.	*Qts.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		*Cents.*
Nov. 20 to Dec. 7,	227.5	12.6	58 50	58.50	–	360.00	–	–	$3.96	1.74
Dec. 19 to 29, .	130.5	11.9	35.75	35.75	88.00	110.00	–	–	1.81	1.39
Jan. 3 to 22, .	277.5	13.9	65.00	65.00	271.00	100.00	–	–	2.82	1.02
Feb. 1 to 17, .	189.8	11.2	55.25	55.25	–	255.00	–	459.00	4.25	2 24
" 20 to 28, .	96 0	10.6	29.25	–	–	135.00	–	243.00	1.91	1.99
Mar. 1 to 8, .	84.5	10.6	26.00	–	–	120.00	–	320.00	1 96	2 32
" 12 to 22, .	122.0	11.1	35.75	35.75	–	165.00	–	297 00	2 75	2.25
" 25 to Apr. 13,	223.5	11.2	65.00	65.00	–	284.00	445.50	–	4.11	1.84
Apr. 18 to May 6,	190.3	10.0	61 75	61.75	–	190.00	566 50	–	3.49	1 83
May 20 to 31, .	107.0	8.9	–	39.00	–	60 00	442.00	–	1.47	1.37
June 4 to 14, .	100.5	9.1	35.75	–	–	55.00	447.00	–	1.35	1.33
" 26 to July 4,	77.0	8.6	29.25	29.25	–	180.00	–	–	1.99	2.51

Analyses of Milk.

(DAISY.)

	1885. Nov. 25.	Dec. 15.	1886. Jan. 6.	Feb. 18.	Feb. 25.	Mar. 4.	Mar. 18.	April 19.	May 14.	May 29.	June 15.	June 21.
Water, . .	87.56	87.65	88.08	86.18	86.62	86.78	85.81	85.97	87.02	87.10	86.75	87.59
Solids, . . .	12.44	12.35	11.92	13 82	13.38	13.22	14.19	14.03	12.98	12.90	13 25	12.41
Fat (in solids), .	3.28	3.56	2.29	4.58	4 30	4.30	4.54	4.93	4.05	4 20	4 62	3.79

(MOLLIE.)

	1885. Nov. 25.	Dec. 15.	1886. Jan 6.	Feb. 18.	Feb. 25.	Mar. 4.	Mar. 18.	April 19.	May 14.	May 29.	June 15.	June 21.
Water, . .	87.16	87.35	87.67	86 35	87.04	87.06	86.61	86 33	87.30	87 25	86.50	87.26
Solids, . . .	12.84	12.65	12.33	13.65	12.96	13.94	13.39	13 67	12.70	12.75	13.50	12.74
Fat (in solids), .	3.82	3.59	3.73	4 28	3.74	4.75	4.03	4.51	3.96	4.24	4.36	3.68

Analyses of the Different Articles of Feed Consumed during the above Experiments.

HAY.

[From Experiment Station, 1885.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	8.30	166.00	–	–	
Dry Matter,	91.70	1,834.00	–	–	
	100.00	2,000.00			
Analysis of Dry Matter.					
Crude Ash,	6.12	122.40	–	–	
" Cellulose,	30.19	603.80	350.20	58	1 : 9.5
" Fat,	2.55	51.00	23.46	46	
" Protein (Nitrogenous Matter),	9.75	195.00	111.15	57	
Non-nitrogenous Extract Matter,	51.39	102.78	647.51	63	
	100.00	2,000.00	1,132.32		

The hay consisted largely of Herd's-grass (*Phleum pratense*) and Red-top (*Agrostis vulgaris*), with a fair admixture of clover.

CORN FODDER.

[From the Experiment Station, 1885.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	15 40	308.00	–	–	
Dry Matter,	84.60	1,692.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	4.22	84.40	–	–	
" Cellulose,	20.93	418.60	301.39	72	1 : 9.3
" Fat,	2.63	52.60	39.45	75	
" Protein (Nitrogenous Matter),	9.17	183.40	133.88	73	
Non-nitrogenous Extract Matter,	63.05	1,261.00	844.87	67	
	100.00	2,000.00	1,319.59		

The above corn fodder was raised under the same conditions, as far as the soil and the fertilizers used are concerned, as the corn for the silos.

CORN ENSILAGE.

[From the Silos of the Experiment Station.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	77.48	1,549.60	–	–	1 : 11.3
Dry Matter, ...	22 52	450.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash, ...	4.19	83.80	–	–	
" Cellulose, . . .	19.08	381.60	274.68	72	
" Fat, ...	3.49	69.80	52.42	75	
" Protein (Nitrogenous Matter), ...	7.82	156.40	114.17	73	
Non-nitrogenous Extract Matter, ...	65.42	1,308.40	876.63	67	
	100.00	2,000.00	1,317.90		

The above analysis represents the mean composition of the ensilage obtained from the silos described in a previous bulletin. The contents of the silos were fed in direct succession, beginning with the silo which had been filled slowly. The corn had been about six months in the silo when the feeding of the ensilage commenced.

CORN MEAL.

[Amherst Mill, 1885.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	12.62	252.40	–	–	1 : 8.76
Dry Matter, ...	87.38	1,747.60	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash, ...	1.56	31.20	–	–	
" Cellulose, ...	2.66	53.20	18.09	34	
" Fat, ...	4.27	85.40	64.90	76	
" Protein (Nitrogenous Matter), ...	11.43	228.60	194.31	85	
Non-nitrogenous Extract Matter, ...	80.08	1,601.60	1,505.50	94	
	100.00	2,000.00	1,782.80		

The average composition of the corn meal during the experiments.

WHEAT BRAN.

[Amherst Mill, 1885.]

81.93 per cent. passed through Mesh 144 to the square inch.

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	12.05	241.00	–	–	1 : 3.77
Dry Matter,	87.95	1,759.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	6.64	132.80	–	–	
" Cellulose,	11.49	229.80	45.96	20	
" Fat,	4.75	95.00	76.00	80	
" Protein (Nitrogenous Matter),	17.86	357.20	314.34	88	
Non-nitrogenous Extract Matter,	59.26	1,185.20	948.16	80	
	100.00	2,000.00	1,384.46		

The average composition of the wheat bran during the experiments.

LANE'S IMPROVED SUGAR BEET.

[From Experiment Station, 1885.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	83.57	1,671.4	–	–	1 : 5.86
Dry Matter,	16.43	328.6	–	–	
	100.00	2,000.0	–	–	
Analysis of Dry Matter.					
Crude Ash,	3.57	71.4	–	–	
" Cellulose,	5.27	105.4	105.4	100	
" Fat,	.83	16.6	16.6	100	
" Protein (Nitrogenous Matter),	17.44	348.8	261.6	75	
Non-nitrogenous Extract Matter,	72.89	1,457.8	1,384.9	95	
	100.00	2,000.0	1,768.5		

Summary of Amount of Digestible Matter contained in the previously described Feeding Periods.

PERIODS.	Total Amount of Food Consumed (in lbs.) during the Entire Period.	Total Amount of Dry Matter Consumed (in lbs.) during the Entire Period.	Digestible Portion of Dry Matter (in lbs.) Consumed during the Entire Period.*	Amount of Digestible Matter Consumed per Day (in lbs.).	Nutritive Ratio.
I., Daisy and Mollie, .	477.00	433.00	267.40	14.86	1: 8.2
II., " " " .	269.50	238.03	158.40	14.40	1: 7.9
III., Daisy, . .	470.00	408.71	276.10	13.81	1: 7.72
III., Mollie, . .	501.00	434.94	293.20	14.66	1: 7.87
IV., Daisy and Mollie,	824.50	406.40	275 80	16.22	1: 7.1
V., " " "	407.25	189.50	123.20	13.69	1: 6.9
VI., " " "	466.00	185.40	124.60	15.58	1: 6.7
VII., " " "	533.50	262.80	178.30	16.21	1: 7.1
VIII., Daisy, . .	834.50	474.63	303.00	15.15	1: 8.14
VIII., Mollie, . .	859.50	474.73	303.70	15.19	1: 8.17
IX., Daisy, . .	878.00	408.63	267.20	14.06	1: 8.15
IX., Mollie, . .	880.00	410.08	268 20	14.12	1: 8 15
X., Daisy, . . .	600.00	201.93	135.90	11.33	1:10.17
X., Mollie, . . .	541.00	199.64	133.90	11.15	1:10.09
XI., Daisy, . .	545.75	184.35	118.70	10.79	1: 8.29
XI., Mollie, . .	537.75	182 54	117.40	10.67	1: 8.25
XII., Daisy and Mollie,	238.50	216.40	136.00	15.11	1: 8.0

* The salines contained in these crops are not included.

I. PERIOD (18 Days).

Daisy and Mollie.

	Total Amount.	Dry Matter.	Digestible Portion.			
			Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Shorts, ...	58.5	51.5	1.2	2.0	8.1	24.4
Meal, ...	58.5	51.4	.5	1.7	5.0	38.7
Hay, ...	360.	330.1	57.8	3.9	17.2	106.9
	477.0	433.0	59.5	7.6	30.3	170.0

Nutritive ratio, 1 : 8.2.

	Daisy.	Mollie.
Amount of dry matter consumed per day, in lbs., . .	24.06	24.06
Quarts of milk produced per day, ...	16 25	12.62

II. PERIOD (11 Days).

Daisy and Mollie.

	Total Amount.	Dry Matter.	Digestible Portion.			
			Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Shorts, ...	35.75	31.44	.7	1.2	4.9	14.9
Meal, ...	35.75	31.27	2.8	1.0	3.1	23.5
Hay, ...	110.00	100.87	17.7	1.2	5.6	32.7
Corn, ...	88.00	74.45	11.2	1.5	5.0	31.4
	269.50	238.03	32.4	4.9	18.6	102 5

Nutritive ratio, 1 : 7.9.

	Daisy.	Mollie.
Amount of dry matter consumed per day, in lbs., . .	21.63	21.63
Quarts of milk produced per day, ...	15.36	11.86

III. PERIOD (20 DAYS).

Daisy.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Meal,	65.00	56.80	.5	1.8	5.5	42.8
Shorts,	65.00	57.17	1.3	2.2	9.0	27.1
Hay,	100.00	91.70	16.0	1.1	5.1	29.7
Corn,	240.00	203.04	30.6	4.0	13.6	85.8
	470.00	408.71	48.40	9.1	33.2	185.4

Mollie.

	Total Amount.	Dry Matter.	Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
Meal,	65.00	56.80	.5	1.8	5.5	42.8
Shorts,	65.00	57.17	1.3	2.2	9.0	27.1
Hay,	100.00	91.70	16.0	1.1	5.1	29.7
Corn,	271.00	229.27	34.5	4.5	15.3	96.8
	501.00	434.94	52.3	9.6	34.9	196.4

	Daisy.	Mollie.
Nutritive ratio,	1:7.72	1:7.87
Amount of dry matter consumed per day, in lbs.,	20.43	21.74
Quarts of milk produced per day,	14.17	13.87

IV. PERIOD (17 Days).

Daisy and Mollie.

	Total Amount.	Dry Matter.	Digestible Portion.			
			Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Meal,	55.25	48.60	.4	1.6	4.7	36.6
Shorts,	55.25	48.59	1.1	1.8	7.6	23.0
Hay,	255.00	233.84	40.9	2.7	13.0	75.7
Roots,	459.00	75.41	4.0	.6	9.9	52.2
	824.50	406.4	46.4	6.7	35.2	187.5

Nutritive ratio, 1 : 7.1.

	Daisy.	Mollie.
Amount of dry matter consumed per day, in lbs.,	23.90	23.90
Quarts of milk produced per day,	14.2	11.16

V. PERIOD (9 Days).

Mollie and Daisy.

	Total Amount.	Dry Matter.	Digestible Portion.			
			Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Shorts,	29.25	25.73	.6	1.0	4.0	12.2
Hay,	135.00	123.80	21.7	1.5	6.9	40.1
Roots,	243.00	39.92	2.1	.3	5.2	27.6
	407.25	189.5	24.4	2.8	16.1	79.9

Nutritive ratio, 1 : 6.9.

	Daisy.	Mollie.
Amount of dry matter consumed per day, in lbs.,	21.05	21.05
Quarts of milk produced per day,	10.61	13.16

VI. PERIOD (8 Days)

Daisy and Mollie.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Hay, . . .	120.00	110.04	19.3	1.3	6.1	35.6
Shorts, . . .	26.00	22.87	.5	.9	3.6	10.8
Roots, ...	320.00	52.58	2.8	.4	6.9	36.4
	466.00	185.44	22 6	2.6	16.6	82.8

Nutritive ratio, 1 : 6.7.

	Daisy.	Mollie.
Amount of dry matter consumed per day, in lbs., . .	23.17	23.17
Quarts of milk produced per day, ...	13.31	10.56

VII. PERIOD (11 Days).

Daisy and Mollie.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Meal, ...	35.75	31.24	.28	1.0	3.0	23.5
Hay, ...	165.00	151.31	26.5	1 8	8.4	49.0
Shorts, ...	35.75	31.44	.7	1.2	4.9	14.9
Roots, ...	297.00	48.80	2.57	.4	6.4	33.8
	533.50	262.8	30.0	4.4	22.7	121.2

Nutritive ratio, 1 : 7.1.

	Daisy.	Mollie.
Amount of dry matter consumed per day, in lbs., . .	23.89	23.89
Quarts of milk produced per day, ...	14.22	11.09

VIII. PERIOD (20 Days.)

Daisy.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Meal, ...	65.00	56.80	.5	1.8	5.5	42.8
Shorts, ...	65.00	57.17	1.3	2.2	9.0	27.1
Hay, ...	292.00	267.76	46.9	3.1	14.9	86.7
Ensilage, . . .	412.50	92.90	12.8	2.4	5 3	40.7
	834.50	474.63	61.5	9.5	34.7	197.3

Mollie.

	Total Amount.	Dry Matter.	Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
Meal, ...	65.00	56.80	.5	1.8	5.5	42.8
Shorts, ...	65.00	57.17	1.3	2.2	9.0	27.1
Hay, ...	284.00	260.43	45.6	3.1	14.5	84.3
Ensilage, . . .	445.50	100.33	13.8	2.6	5.7	44.0
	859.50	474.73	61.2	9.7	34.7	198.1

	Daisy.	Mollie.
Nutritive ratio, ...	1:8.14	1:8.17
Amount of dry matter consumed per day, in lbs., .	23.73	23.73
Quarts of milk produced per day, ...	12.8	11.2

IX. PERIOD (19 Days).

Daisy.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Meal, ...	61.75	53.96	.5	1.7	5.3	40.5
Shorts, ...	61.75	54.31	1.2	2.1	8.5	25.7
Hay, ...	190.00	174.23	30.5	2.0	9.7	56.4
Ensilage, . . .	564.50	126.13	17.3	3.3	7.2	55.3
	878.00	408.63	49.5	9.1	30.7	177.9

Mollie.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
Meal,	61.75	53.96	.5	1.7	5.3	40.5
Shorts,	61.75	54.31	1.2	2.1	8.5	25 7
Hay,	190.00	174.23	30.5	2.0	9.7	56.4
Ensilage,	566.50	127.58	17.5	3.3	7.3	56.0
	880.00	410.08	49.7	9.1	30.8	178.6

	Daisy.	Mollie.
Nutritive ratio,	1:8.15	1:8.15
Amount of dry matter consumed per day, in lbs.,	21.51	21.58
Quarts of milk produced per day,	11.0	10.6

X. PERIOD (12 Days).

Daisy.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Meal,	39.00	34.08	.3	1.1	3.3	25.7
Hay,	60.00	55.02	9.6	.6	3.1	17.8
Ensilage,	501.00	112.83	15.5	3.0	6.4	49.5
	600.00	201.93	25.4	4.7	12.8	93.0

Mollie.

	Total Amount.	Dry Matter.	Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
Meal,	39.00	34.08	.3	1.1	3.3	25.7
Hay,	60.00	55.02	9.6	.6	3.1	17.8
Ensilage,	442.00	110.54	15.1	2.9	6.3	48.1
	541.00	199.64	25.0	4.6	12.7	91.6

	Daisy.	Mollie.
Nutritive ratio,	1:10.17	1:10.09
Amount of dry matter consumed per day, in lbs.,	16.82	16.63
Quarts of milk produced per day,	9.2	8.9

XI. PERIOD (11 Days.)

Daisy.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Shorts, ...	35.75	31.44	.7	1.2	4.9	15.9
Hay, ...	55.00	50.44	8.8	.6	2.8	16.3
Ensilage, . . .	455.00	102.47	14.1	2.7	5.8	44.9
	545.75	184.35	23.6	4.5	13.5	77.1

Mollie.

	Total Amount.	Dry Matter.	Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
Shorts, ...	35.75	31.44	.7	1.2	4.9	15.9
Hay, ...	55.00	50.44	8.8	6	2.8	16.3
Ensilage, . . .	447.00	100.66	13.8	2.6	5.7	44.1
	537.75	182.54	23.3	4.4	13.4	76.3

	Daisy.	Mollie.
Nutritive ratio, ...	1 : 8.29	1 : 8.25
Amount of dry matter consumed per day, in lbs., .	16.76	16.59
Quarts of milk produced per day, ...	8.9	9.1

XII. PERIOD (9 Days).

Daisy and Mollie.

	Total Amount.	Dry Matter.	Digestible Portion. Cellulose.	Fat.	Protein.	Non-nitrogenous Extract Matter.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Meal, ...	29.25	25.56	2.3	.8	2.5	19.2
Shorts, ...	29.25	25.73	.6	1.0	4.0	12.2
Hay, ...	180.00	165.06	28.9	1.9	9.2	53.4
	238.50	216.4	31.8	3.7	15.7	84.8

Nutritive ratio, 1 : 8.

	Daisy.	Mollie.
Amount of dry matter consumed per day, in lbs., . .	24.04	24.04
Quantity of milk produced per day, ...	8. 4	8.6

Milk and Creamery Record from November 17, 1885, to April 30, 1886.

	Quarts of Milk Produced.	Spaces of Cream from Milk.	Price allowed per Space.	Am't received from Creamery.
1885.				
November 17 to 30, . .	764	348	4 cts.	$13.92
December 1 to 31, . .	862	409	4 "	16.36
1886.				
January 1 to 31, . . .	785	355	4 "	14.20
February 1 to 28, . . .	695	324	4 "	12.96
March 1 to 31, . . .	772	339	4 "	13 56
April 1 to 30, . . .	688	257	4 "	10.28
	4,566	2,032	–	$81.28

November, 1885. 6.38 spaces of cream made 1 lb. butter, equal to 25.52 cents per pound.
December, " 6.50 spaces of cream made 1 lb. butter, equal to 26 cents per pound.
January, 1886. 6.54 spaces of cream made 1 lb. butter, equal to 26.16 cents per pound.
February, " 6.65 spaces of cream made 1 lb. butter, equal to 26.60 cents per pound.
March, " 6.34 spaces of cream made 1 lb. butter, equal to 25.36 cents per pound.
April, " 6.13 spaces of cream made 1 lb. butter, equal to 24.52 cents per pound.

MILK ANALYSIS.

[Samples sent on for Examination.]

	1	2	3	4
Specific gravity, .	1.0375	1.032	1.0329	1.0296
Temperature, C., .	19.°	20.°	17.5°	.23°
Solids, . . .	10.25 per ct.	13.67 per ct.	14.37 per ct.	15.36 per ct.
Fat, . . .	.42 "	4.15 "	4.87 "	5.44 "
Solids not fat, .	9.83 "	9.52 "	9.50 "	9.92 "

These samples are from the vicinity of Amherst. No. 1 is skim milk.

2. Fodder and Fodder Analyses.

The application of an intelligently devised system of chemical tests, for the purpose of ascertaining the amount and the relative proportions of the essential proximate constituents of our fodder articles, has rendered valuable services to practical agriculture. The chemical analysis of plants during their successive stages of growth has shown marked alterations in their composition, as far as the *absolute amount* of vegetable matter, as well as the *relative proportion* of the essential plant-constituents, are concerned. It has rendered not less conspicuous the important influence which the soil in its varying state of fertility exerts on the quantity and the quality of the growth raised upon it. The lessons derived from this source of information have stimulated inquiries concerning the safest modes of manuring, of cultivating and of harvesting our different farm crops with the prospect of securing the most satisfactory returns under existing circumstances.

A better knowledge regarding the particular quality of the various articles of fodder at our disposal improves our chances of supplementing them judiciously and thus economically, for different kinds of farm live-stock, as well as for different conditions and functions of the same kind. It furnishes, also, a safer basis for the explanation of the results obtained in actual feeding experiments. To study the nutritive value or feeding effect of any of our fodder articles by actual feeding experiments, without learning, as far as practicable, something more definite regarding its peculiar quality or composition, deprives the results obtained largely of their general interest, for they are secured under ill-defined circumstances. The chemical analysis of an article of fodder is for these reasons considered the first step required to render an intelligent interpretation of the results in feeding trials possible. Actual feeding experiments have shown that *three groups of plant constituents*, namely, *nitrogenous*, *non-nitrogenous* and *mineral constituents*, are *needed* to successfully sustain animal life. No one or two of them, alone, can support it for any length of time. In case the food does not contain digestible non-nitrogenous substances,

the fat and a portion of the muscles of the animal on trial will be consumed in the support of respiration before its life terminates. In case digestible nitrogenous constituents are excluded from the diet, the formation of new blood and flesh from the food consumed ceases; for the animal system, according to our present state of information, is not capable of producing its principal constituents from anything else than the nitrogenous constituents of the plants.

Herbivorous animals receive these substances directly from the plants; carnivorous animals indirectly, by feeding on herbivorous animals. We feed, at present, our farm-stock too frequently, without a due consideration of the general natural law of nutrition; to deal out our fodder crops only with mere reference to name, instead of making ourselves more familiar with their composition and their particular quality, deprives us even of the chance of drawing an intelligent conclusion from our present system of feeding.

To compound the animal diet with reference to the particular organization of the animal, its age and its functions, is of no more importance than to select the fodder substances with reference to its special wants, as far as the absolute and relative quantity of the three essential groups of food constituents are concerned.

The peculiar character of our home-raised fodder articles is apt to conceal their special deficiency for the various purposes they are used for in general farm management. They all contain the three essential food constituents, yet in widely varying proportions; and they ought, therefore, to be supplemented in different directions to secure their full economical value. To resort to more or less of the same fodder article to meet the special wants, may meet the case as far as an efficient support of the animal is concerned, yet it can only in exceptional cases be considered good economy.

To satisfy the craving of the stomach and to feed a nutritious food are both requirements of a healthy animal diet, which, each in its own way, may be complied with. The commercial fodder substances — as oil-cakes, mill refuse brans, and our steadily-increasing supply of refuse materials from breweries, starch works, glucose factories, etc. — are

admirably fitted to supplement our farm resources for stock feeding; they can serve in regard to animal growth and support, in a similar way as the commercial fertilizers in the growth of our farm crops, by supplementing our home manurial resources. To feed an excess of food materials, as roots, potatoes, etc., which contain a large proportion of non-nitrogenous matter, as starch, sugar, digestible cellular substance, etc., means direct waste, for they are ejected by the animal, and do not even materially benefit the manure heap. In case of an excessive consumption of nitrogenous constituents,— as oil-cakes, brans, gluten meal, etc., — a part of the expense is saved in an increased value of the manure obtained, yet scarcely enough to recommend that practice beyond merely exceptional cases. The aim, therefore, of an economical stock-feeding must be to compound our various fodder materials in such a manner that the largest quantity of each of the three above-stated groups of fodder substances, which the animal is capable of assimilating, should be contained in its daily diet to meet the purpose for which it is kept.

To compound the fodder rations of our farm stock, with reference to the special wants of each class of them, is an essential requirement for a satisfactory performance of their functions; to supply these wants in an economical way controls the financial success of the industry. From these and similar considerations it will be apparent that the development of a more rational, and thus more economical, system of feeding farm live-stock requires the following kind of information: —

First. How much of each of the three essential groups of food-constituents is contained in the fodder we feed?

Second. How much of each of these essential food-constituents is digestible under existing circumstances, and is thus directly available to the particular animal on trial?

Third. How much of each of the three essential food-constituents does each kind of animal require to secure the best results?

More than twenty-five years have passed by since these questions have seriously engaged the attention of skilful experimenters. Sufficient valuable information has been

secured in the course of time to encourage the use of the adopted methods of observation, and to impart to many of the conclusions arrived at, a just claim for a serious consideration on the part of practical agriculturalists. The fact that much needs still to be learned to meet the reasonable expectations of those engaged in the development of a more economical system of feeding farm live-stock cannot be considered a valid reason why we should not make an intelligent use of what we have learned.

The chemical analysis of a fodder article is carried on with a view to determine the quantity of each group of its constituents, which is considered an essential ingredient of a complete food for the support of animal life. Our modes of analyzing articles of fodder are practically the same, wherever this work is carried out intelligently. The results obtained are, therefore, applicable for the determining of a comparative value wherever the identity of the material can be established.

The actual results of the analysis are usually reported under the following headings: —

1. Amount of moisture lost at 110° C., or 230° F., and amount of dry matter left behind.

2. Amount of mineral matter left behind after a careful incineration of the material.

3. Amount of organic nitrogenous matter, commonly called crude protein.

4. Amount of non-nitrogenous organic matter, exclusive of fat and of coarse cellulose substances.

The entire mass which any fodder substance leaves behind after being heated at one hundred and ten degrees, Centigrade thermometer, is called dry matter. An increase in dry substance in case of any plant or part of plant at the same stage of growth, indicates usually a higher feeding value. To satisfy the cravings of the animal, a certain quantity or bulk of coarse, dry matter becomes an important consideration in making up the fodder rations for different classes of animals. In raising young stock for fattening purposes, a liberal supply is also desirable, to effect a proper distention of the digestive organs, to make them good feeders hereafter.

Nitrogenous substances, or protein matter, refer to several groups of nitrogen-containing compounds, of plants in particular, as albumin, fibrin, legumin, casein, etc., which are essential for the formation of blood and tissues. Those contained in animal matter, as meat refuse, are frequently considered of a higher value than those in many plants.

Non-nitrogenous substances include, in particular, starch, sugars, organic acids, gums, fats and the digestible portion of the cellular matter of the fodder. These substances are readily transformed within the digestive organs into soluble compounds of a similar chemical character, and are thus assumed to serve an identical physiological purpose. As more recent investigations have shown a superior physiological value of fat, — one of the non-nitrogenous constituents, — two and one-half times as much as starch, sugar, and other representatives of that group, its amount is separately recorded. The same course, for similar reasons, has of late been adopted with reference to certain forms of nitrogenous organic constituents of fodder articles.

Fatty substances include all the various natural fats of the plant. Most plants contain more than was assumed at an earlier stage of inquiry. As the fat is separated by means of ether, the statements in the analyses do not exactly express the amount of fatty matter alone, but include more or less resinous substances, wax, etc., which are largely soluble in ether, and of a similar highly carbonaceous character. The fat of the fodder seems to serve, in case of judicious fodder rations, mainly to increase the stock of fat in the animal which consumes the fodder.

Wherever the article has been tested by actual feeding experiment under skilful observation, the amount of each essential group of food constituents which has been shown to be digestible is reported in connection with the chemical analysis, under the heading *Digestible Portion*, per hundred weight or per ton. The higher or lower degree of digestibility of a fodder article exerts a decided influence on its nutritive value. Different stages of growth affect the rates of digestibility of the various plant constituents. The same feature is noticed in regard to different parts of plants, as well as in case of different kinds of animals.

More than two hundred fodder articles have thus far been studied under varying circumstances, and most of our current kinds of fodders have been tested in Europe and elsewhere, in numerous well-conducted feeding experiments with a suitable selection of different kinds of farm live-stock. This fact imparts to many of the results recorded a sufficient importance to recommend them as a basis of new feeding trials, with feed stuffs raised in our climate, or obtained in our home industries.

The last, but not least important, column of the statement of the chemical analysis — quite frequently found in the general record of a fodder for a practical agricultural purpose — is that of "Nutritive Ratio." These words are used to express the numerical relation of its *digestible nitrogenous substances* taken as one, as compared with the sum of its *digestible non-nitrogenous organic substances*, fat included. The information derived from that statement is very important; for it means to express the summary of results secured by actual feeding trials under specified conditions, and with the aid of the best-endorsed chemical modes to account for the constituents of the food before and after it has served for the support of the animal on trial.

Experience has shown that different kinds of animals, as well as the same kind at different ages and for different functions, require a different proportion of the essential groups of food constituents to produce in each case the best results. A statement of the nutritive ratio of a fodder article — otherwise well adapted as an ingredient of a daily diet in the case under consideration — indicates the direction in which the material has to be supplemented to economize to a full extent its various constituents.

Practical trials with milch cows have demonstrated that they require for the highest production of a good milk and the maintenance of a healthy live weight, the most nutritious food we are in the habit of giving to full-grown farm animals. Careful examinations into the composition of an efficient diet for milch cows have shown that it contains one part of digestible nitrogenous matter to from five to five and a half parts of digestible non-nitrogenous organic matter. A due consideration of these facts renders it but natural that a

good corn ensilage, which has a nutritive ratio of from 1 to 10 to 1 to 12, needs a liberal addition of substances like oil-cakes, wheat bran, gluten meal, etc., which have a nutritive ratio of 1 to from 2.5 to 4, to secure its full value as an ingredient of a daily diet in the dairy; or that good hay shows less the beneficial effects of an addition of these valuable waste products than that of an inferior quality. The nutritive ratio of hay may vary from 1 to 5.5 to from 1 to 9 or more.

The value of an article of fodder may be stated from two different standpoints, — that is, with reference to its cost in the local market, and with reference to its nutritive feeding value. The market price may be expressed by a definite sum for each locality; it depends on demand and supply in the market, and it is beyond the control of the individual farmer. The nutritive value, or commonly called food value, of the article cannot be expressed by a definite sum; it varies with a more or less judicious application, and depends also, to a considerable degree, on its adaptation under varying circumstances. To secure the most satisfactory returns from feeding our home-raised fodder crops is as important a question as that of raising them in an economical manner. The great progress which has been made during the past ten or twelve years in regard to the proper mode of feeding plants ought to serve as an encouragement to undertake the task of inquiring more systematically into the proper mode of feeding our farm live-stock in the most profitable way.

CHICAGO GLUTEN MEAL.

[Bought at Springfield, Mass., 1886.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C ,	8.95	179.00	–	–	1 : 3.00
Dry Matter,	91.05	1,821.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	.76	15.20	–	–	
" Cellulose,	1.58	31.60	10.74	34	
" Fat,	7.51	150.20	114.15	76	
" Protein (Nitrogenous Matter),	30.81	616.20	523.77	85	
Non-nitrogenous Extract Matter,	59.34	1,186.80	1,115.59	94	
	100.00	2,000.00	1,764.25	–	

WHEAT BRAN.

[From a mill in Amherst, 1886.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	10.00	200.00	–	–	1 : 3.84
Dry Matter,	90.00	1,800.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	6.11	122.20	–	–	
" Cellulose,	7 60	152.00	30.40	20	
" Fat,	6.08	121.60	97.28	80	
" Protein (Nitrogenous Matter),	18.63	372.60	327.89	88	
Non-nitrogenous Extract Matter,	61.58	1,231.60	985.28	80	
	100.00	2,000.00	1,440.85	–	

WHEAT MIDDLINGS.

[Sent on from Bolton, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	10.55	211.00	Not determined by actual feeding tests.	Not determined by actual feeding tests.	
Dry Matter,	89.45	1,789.00			
	100.00	2,000.00			
Analysis of Dry Matter.					
Crude Ash,	2.49	49.80			
" Cellulose,	1.40	28.00			
" Fat,	4 26	85.20			
" Protein (Nitrogenous Matter),	19.21	384.20			
Non-nitrogenous Extract Matter,	72.64	1,452.80			
	100.00	2,000.00			

The composition is very fair, and its mechanical condition was not less satisfactory.

WHEAT MIDDLINGS.

[Sent from Barre, Mass.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9 85	197.00	Not determined by actual feeding tests.	Not determined by actual feeding tests.	
Dry Matter,	90.15	1,803.00			
	100.00	2,000.00			
Analysis of Dry Matter.					
Crude Ash,	2.53	50.60			
" Cellulose,	2.75	55.00			
" Fat,	3.19	63.80			
" Protein (Nitrogenous Matter),	17.23	344.60			
Non-nitrogenous Extract Matter,	74.30	1,486.00			
	100.00	2,000.00			

This material contains less fat and nitrogenous matter than the previous one, yet not less than samples from the same mill may show at different times.

RYE BRAN.

[From Amherst Mill, 1886.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	8.18	163.60	–	–	1 : 5.45
Dry Matter,	91.82	1,836.40	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	3.43	68.60	–	–	
" Cellulose,	3.46	69.20	6.23	9.0	
" Fat,	3.03	60.60	34.85	57.5	
" Protein (Nitrogenous Matter),	16.52	330.40	218.06	66.0	
Non-nitrogenous Extract Matter,	73.56	1,471.20	1,096.04	74.5	
	100.00	2,000.00	1,355.18	–	

The material has a fair composition. Recent observations by careful observers seem to indicate that it ought not to take the place of wheat bran in the dairy.

HOMINY MEAL.

[Sent on from Berlin, Mass.]

51.64 per cent. passed through Mesh 144 to square inch.

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	10.70	214.00	–	–	1 : 8.75
Dry Matter,	89.30	1,786.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	2.82	56.40	–	–	
" Cellulose,	3.69	73.80	25.09	34	
" Fat,	10.88	217.60	165.38	76	
" Protein (Nitrogenous Matter),	11.88	237.60	201.96	85	
Non-nitrogenous Extract Matter,	70.73	1,414.60	1,329.72	94	
	100.00	2,000.00	1,722.15	–	

The composition is that of a good article of its kind.

CORN COB MEAL (CORN AND COB).

[Collected at a mill near Amherst, Mass., 1886.]

	Per cent.
Moisture at 100° C.,	9.45
Dry Matter,	90.55
	100.00

Analysis of Dry Matter.

	Per cent.
Crude Ash,	1.64
" Cellulose,	6.32
" Fat,	5.19
" Protein (Nitrogenous Matter),	9.85
Non-nitrogenous Extract Matter,	77.00
	100.00

The composition of this article depends somewhat on the relative weight of cob and kernels; the former may vary from 14 to 18 per cent. in current varieties. See article "On different varieties of corn, etc." (Secretary's Report of Massachusetts State Board of Agriculture, 1879–80, pages 222 to 254).

YELLOW SWEET CORN.

[Raised on the fields of the Experiment Station, 1885.]

Ears from five to seven inches in length, having eight rows of kernels. Weight of an average ear, 70.16 grammes; weight of kernels, 57.40 grammes, or 81.8 per cent.; weight of cob, 12.76 grammes, or 18.2 per cent. Average weight of a kernel, 0.232 grammes.

	Per cent.
Moisture at 100° C.,	10.90
Dry Matter,	89.10
	100.00

Analysis of Dry Matter.

	Per cent.
Crude Ash,	2.16
" Cellulose,	2.58
" Fat,	4.25
" Protein (Nitrogenous Matter),	12.61
Non-nitrogenous Extract Matter,	78.40
	100.00

The article is somewhat deficient in fat, as compared with "Blue Mexican" or Crosby's.

"SELF-HUSKING" CORN.

[Experiment Station, 1885.]

Ears eight rows, eight to ten inches long. Kernels of a reddish or brownish red color. Weight of an average ear, 142.7 grammes; consisting of 88.08 per cent. kernels, and 11.92 per cent. cob. Average weight of a single kernel, .37 grammes.

	Per cent.
Moisture at 100° C.,	12.10
Dry Matter,	87.90
	100.00

Analysis of Dry Matter.

	Per cent.
Crude Ash,	1.74
" Cellulose,	2.52
" Fat,	5.44
" Protein (Nitrogenous Matter),	12.47
Non-nitrogenous Extract Matter,	77.83
	100.00

SWEET APPLE POMACE.

[Sent on for examination from Prescott, Mass., 1885.]

	Per cent.
Moisture at 100° C.,	77.87
Dry Matter,	22.13
	100.00

Analysis of Dry Matter.

	Per cent.
Crude Ash,	1.96
" Cellulose,	8.82
" Fat,	3.16
" Protein (Nitrogenous Matter),	6.70
Non-nitrogenous Extract Matter,	79.36
	100.00

CORN REFUSE FROM STARCH FACTORY.

[Sent on from New Bedford, Mass.]

	Per cent.
Moisture at 100° C.,	57.04
Dry Matter,	42.96
	100.00

Analysis of Dry Matter.

	Per cent.
Crude Ash,	0.90
" Cellulose,	7.54
" Fat,	10.17
" Protein (Nitrogenous Matter),	22.41
Non-nitrogenous Extract Matter,	58.98
	100.00

The above-named material, which furnished the sample sent on for examination, had been bought at a corn-starch factory at Long Island, N. Y., for feeding cattle. Forty tons had been loaded at New Bedford, at $8 per ton of forty bushels. Some doubts had been expressed in regard to its fitness as a feed for milch cows.

The sample we received was apparently in a fair state of preservation, and consisted mainly of a soft, yellowish-white mass, interspersed with coarse fragments of the skin of the corn. The entire mass, in an air-dried state, was quite soft and friable, and of a peculiar vegetable, yet not offensive odor.

The composition of the vegetable matter contained in the article is that of a valuable ingredient for the compounding of a suitable diet for various kinds of farm live-stock, and in some respects similar to that of the refuse grain from breweries. The main objectionable feature of the fresh factory refuse consists in the presence of a large amount of moisture, and its liability to suffer a rapid and serious deterioration in consequence of a careless keeping, in particular during the warmer seasons of the year. Two modes of treatment for the preservation of fodder articles like the one here under discussion suggest themselves in this connection, — the silo system and the drying apparatus. The above-described corn-starch factory refuse, in its dried state, could command a price from $16 to $18 per ton in our markets.

The fitness of this class of refuse material from glucose and starch factories, as well as from brewers' grains, as an ingredient of a daily fodder ration for all kinds of farm live-stock, the dairy cow included, is quite generally conceded, provided they are in a fair state of preservation. Excessive and exclusive feeding of many fodder articles is an objectionable practice; this applies as much to corn ensilage, roots and apples, as to the waste products of the factories above enumerated.

All fodder articles of a perishable character deserve the serious attention of farmers, for they are apt to become objectionable sooner or later, if carelessly kept. In an advanced state of fermentation they are decidedly objectionable, for various reasons; they may become even poisonous in consequence of their liability to turn into hot-beds of a dangerous, parasitic

growth. Musty corn meal, oil cakes, etc., are known to have been the direct cause of the death of cows.

"THE CONCENTRATED FEED."

[Sent on by South Deerfield Farmers' Club, South Deerfield, Mass.]

97.52 per cent. passed through Mesh 144 to the square inch.

	Per cent.
Moisture at 100° C.,	10.65
Crude Ash,	14.48
" Cellulose,	9.31
" Fat,	4.30
" Protein (Nitrogenous Matter),	13.90
Non-nitrogenous Extract Matter,	47.36
	100.00

Analysis of Dry Matter.

	Per cent.
Crude Ash,	16.21
" Cellulose,	10.42
" Fat,	4.81
" Protein (Nitrogenous Matter),	15.56
Non-nitrogenous Extract Matter,	53.00
	100.00

The material was received in a bag marked "The Concentrated Feed Company, Boston, Mass." A circular, from the agent at South Deerfield, contained a statement of an analysis of the article, which, as far as essential points are concerned, does not materially differ from our own, above reported.

The material was of a good, mechanical condition, and consisted evidently of a mixture of several ingredients; among them was noticeable common salt. An actual test showed the presence of 7.4 per cent. of chlorine, which indicates the presence of from 11 to 12 per cent of common salt. On inquiry it was learned that "The Concentrated Feed" sold at $8 per one hundred weight, — a most remarkable price for an article of fodder without any stated guaranty of its various ingredients, nor any statement of its rate of digestibility under some specified conditions. The selling price of the article seems to be based largely on the merits of the invention of the compound. It would be no difficult task to compound from our most reputed concentrated feed-stuffs, even without a lib-

eral addition of common salt, an article which would conform to the composition claimed by the manufacturer of "The Concentrated Feed," and at the same time could be sold with a good compensation to the agent, even in remote localities, at a less price per ton than "The Concentrated Feed" sells for per five hundred pounds.

From remarks in previous pages it must be apparent that a mere analysis of a fodder article, without any further reliable information concerning its source and its special character, is no safe basis for a decision regarding its particular value for feeding purposes. The practice of buying compound feed-stuffs in the general market, without a sufficient actual knowledge regarding the kind or the character of their varied ingredients, ought to be decidedly discouraged; for the farmer who pursues that course leaves his best interests to mere chance. To feed commercial compound feed-stuffs without some more positive knowledge of the articles which constitute them can impart but little useful information for future operation beyond the lesson to be less credulous hereafter.

3. ANALYSES OF FEED-STUFFS WITH REFERENCE TO THE FERTILIZING CONSTITUENTS THEY CONTAIN.

The composition of the various articles of food used in farm practice exerts a decided influence on the manurial value of the animal excretions resulting from their use in the diet of different kinds of farm live-stock. The more potash, phosphoric acid, and in particular nitrogen, a fodder ingredient contains, the more valuable will be, under otherwise corresponding circumstances, the manurial residue left behind, after it has served its purpose as a constituent of the food consumed.

As the financial success in most farm managements depends in a considerable degree on the amount, the character and the cost of the manurial refuse material secured in connection with the special farm industry carried on, it needs no further argument to prove that the relations which exist between the composition of the fodder and the value of the manure resulting, deserves the careful consideration of the farmer, when devis-

ing an efficient and at the same time an economical diet for his live stock.

The question whether one or the other fodder mixture will prove ultimately, under otherwise corresponding circumstances, the cheapest one, can only be answered intelligently when both the original cost of the feed consumed and the value of the manurial residue subsequently obtained are duly considered.

The close relation, which quite necessarily exists in most farm managements between the system of cultivating the lands and the keeping of farm live-stock for farm work, for the dairy and for the supply of food for the general market, imparts to the barn-yard manure a special if not a controlling importance as a valuable manurial resource. The barn-yard manure ought to remain in a judicious system of mixed farming, — not only the main reliance of the farmer for plant food, but also the cheapest manure at his disposal. The objections raised at times against a liberal use of barn-yard manure ought not to rest on its higher cost of production, when compared with other manurial substances in our market. The name "barn-yard manure" is, however, too frequently used without any particular discrimination with reference to all kinds of manurial refuse obtained in connection with stock feeding and stock raising, which are frequently of widely differing composition. To approximate even fairly the comparative value of two samples obtained on different farms remains a hopeless task, as long as a more definite information regarding the following points is wanting: —

1. The character of the fodder consumed.

2. The kind, the age and the function of the animal which served for its production.

3. The nature and the quantity of the material which served for the absorption of the animal excretions.

4. The care bestowed upon collecting and preserving the entire liquid and solid excretions.

Assuming for our present purpose, in both instances, identical conditions, as far as the kind of animal, the mode of collecting and the care of keeping the manure are concerned, it will be apparent that the relative value of the two kinds of barn-yard manure stand essentially in a direct relation to the amount

of nitrogen, potash, phosphoric acid, etc., which was contained in the feed consumed.

The following analyses of fodder articles are obtained at the laboratory of the Station, from fair samples which came under our observation.

A series of similar analyses of fodder crops, based mainly on the average analyses of E. Wolff, are published in the Annual Report of the Secretary of the Massachusetts Board of Agriculture for 1885, page 146.

1. CORN COBS.

[Average result of four current varieties of corn raised in Hampden and Hampshire counties, Mass.]

	Per cent.
Moisture at 100° C.,	10.00
Nitrogen in organic matter (17 cents per pound),	0.54
Crude ash,	1.03
Silica,	0.20
Ferric oxide,	0.01
Calcium oxide,	0.03
Magnesium oxide,	0.06
Potassium oxide (4¼ cents per pound),	0.68
Sodium oxide,	0.04
Phosphoric acid (6 cents per pound),	0.08
Valuation per 2,000 lbs.,	$2.52

2. CORN MEAL.

[From mill at Amherst, Mass.]

	Per cent.
Moisture at 100° C.,	10.00
Nitrogen in organic matter (17 cents per pound),	1.86
Crude ash,	1.50
Silica,	0.005
Ferric oxide,	0.015
Calcium oxide,	0.027
Magnesium oxide,	0.197
Potassium oxide (4¼ cents per pound),	0.45
Sodium oxide,	0.064
Phosphoric acid (6 cents per pound),	0.77
Valuation per 2,000 lbs.,	$7.62

3. VILMORIN (SUGAR BEET). 4. GLOBE MANGOLD.

	Pounds per Hundred.	
	3	4
Moisture at 100° C.,	85.99	88 27
Dry matter,	14.01	11.73
Nitrogen (17 cents per pound),	.29	.30
Crude ash,	.62	.94
Potassium oxide (4¼ cents per pound),	.18	.44
Sodium oxide,	.18	.30
Calcium oxide,	.06	.03
Magnesium oxide,	.04	.04
Phosphoric acid (6 cents per pound),	.03	.02
Ferric oxide,	.01	.003
Insoluble matter,	.10	.09
Valuation per 2,000 lbs.,	$1.18	$1.43

Relative Percentage of Soluble Essential Constituents in One Hundred Parts of Ash (3-4).

	3	4
Potassium oxide,	36.648	53.156
Sodium oxide,	35.795	35.764
Calcium oxide,	11.932	3.366
Magnesium oxide,	7.103	4.488
Phosphoric acid,	6.534	2.805
Ferric oxide,	1.988	0.421
	100.000	100.000

WHOLE APPLES.

5. Rhode Island Greenings. 6. Sweet Apples.

	Pounds per Hundred.	
	5	6
Moisture at 100° C.,	84.650	75.170
Dry matter,	15.350	24.830
Nitrogen (17 cents per pound),	.113	.156
Crude ash,	.327	.501
Potassium oxide (4¼ cents per pound),	.122	.269
Sodium oxide,	.013	.042
Calcium oxide,	.023	.044
Magnesium oxide,	.025	.029
Ferric oxide,	.001	.005
Phosphoric acid (6 cents per pound),	.008	.011
Insoluble matter,	.002	.004
Valuation per 2,000 lbs.,	$0 49	$0 60

APPLE POMACES.

7. Rhode Island Greenings. 8. Baldwin Apple.

	Pounds per Hundred.	
	7	8
Moisture at 100° C.,	78.220	82.780
Dry matter,	21.780	17.220
Nitrogen (17 cents per pound),	.241	.213
Crude ash,	.237	.306
Potassium oxide (4¼ cents per pound),	.119	.150
Sodium oxide,	.032	.020
Calcium oxide,	.042	.032
Magnesium oxide,	.027	.028
Ferric oxide,	.008	.008
Phosphoric acid (6 cents per pound),	.017	.018
Insoluble matter,	.009	.008
Valuation per 2,000 lbs.,	$0 92	$0 87

The composition of the apples which served for the above analyses of pomaces has been described in the Third Annual Report of the Experiment Station, pages 86, 87.

9. WHEAT MEAL.

[From a mill in Amherst, Mass.]

	Per cent.
Moisture at 100° C.,	9.83
Nitrogen in organic matter (17 cents per pound),	2.21
Crude ash,	1.22
Magnesium oxide,	0.05
Calcium oxide,	0.17
Potassium oxide (4¼ cents per pound),	0.54
Sodium oxide,	1.06
Phosphoric acid (6 cents per pound),	0.57
Valuation per 2,000 lbs.,	$8 65

10. WHEAT MIDDLINGS.

[From a mill in Amherst, Mass.]

	Per cent.
Moisture at 100° C.,	9.18
Nitrogen in organic matter (17 cents per pound),	2.63
Crude ash,	2.30
Magnesium oxide,	0.21
Potassium oxide (4¼ cents per pound),	0.63
Calcium oxide,	0.20
Sodium oxide,	0.11
Phosphoric acid (6 cents per pound),	0.95
Valuation per 2,000 lbs,	$10 63

11, 12. WHEAT BRAN.

[From a mill in Amherst, Mass.]

	Per cent. 11	12
Moisture at 100° C.,	11.45	9.40
Phosphoric acid (6 cents per pound),	3.05	3.12
Magnesium oxide,	0.90	0.91
Sodium oxide,	0.09	0.16
Potassium oxide (4¼ cents per pound),	1.49	1.42
Nitrogen in organic matter (17 cents per pound),	2.82	3.08
Insoluble matter,	0.11	0.15
Valuation per 2,000 lbs.,	$14 52	$15 42

The above analyses refer to the quality of bran fed of late at the Station.

13. PROVENDER.

	Per cent.
Moisture at 100° C.,	10.48
Phosphoric acid (6 cents per pound),	0.78
Magnesium oxide,	0.05
Calcium oxide,	0.18
Sodium oxide,	0.22
Potassium oxide (4½ cents per pound),	0.37
Nitrogen in organic matter (17 cents per pound),	2.10
Insoluble matter,	0.29
Valuation per 2,000 lbs.,	$8 40

The above provender consisted of 100 lbs. of wheat bran, 125 lbs. of oats and 450 lbs. of corn-meal.

14. GLUTEN MEAL.

[Bought at Springfield, Mass.]

	Per cent.
Moisture at 100° C.,	9.00
Nitrogen in organic matter (17 cents per pound),	5.44
Crude ash,	0.70
Calcium oxide,	0.058
Magnesium oxide,	0.034
Potassium oxide (4½ cents per pound),	0.06
Sulphuric acid,	0.021
Phosphoric acid (6 cents per pound),	0.45
Valuation per 2,000 lbs.,	$19 05

FIELD EXPERIMENTS.

[Field A.]

1. Fodder Corn raised upon underdrained and exhausted Lands, partly Fertilized with Single Articles of Plant Food, partly without the use of any Manurial Matter.

In the First Annual Report of the Station has been described the underdraining of a piece of land, one and one-tenth of an acre in size, subdivided into eleven plats. The field was to serve for an examination into the actions of various manurial substances on the growth of corn, and the influence on the character of the drainage water discharged from the drains, under a different treatment of the soil. It had been used for several years previous to the establishment of the Experiment Station in 1882 as a meadow for the production of hay. During the spring of 1883 it was planted with corn (Longfellow variety), for fodder corn, without the use of any fertilizer. The same course of planting and cultivation was carried out during 1884 (changing from the Longfellow to the Clark variety of corn) for the purpose of exhausting the soil, as far as practicable, for the cultivation of corn with any prospect of remunerative returns.

The corn crop raised in 1884 upon these eleven plats of unmanured land left no doubt about their exhausted condition, as far as a further successful cultivation of corn was concerned; for the entire yield of corn fodder from this piece of land, one and one-tenth of an acre in size, amounted to 5,040 pounds, with a moisture of thirty per cent.

These results encouraged the beginning of a special inquiry into the chemical and physical condition of our soil, as far *as its relation to the production of the corn crop is concerned*, as well as into *its particular power to retain*, in a higher or lower degree, *various articles of plant food;* i. e., its qualification to prevent their passage into the drainage water.

With these ends in view, the following course was decided upon, and carried out during the succeeding season (1885).

The entire field (A) was prepared, May 12, in a similar manner for the planting of corn as in preceding years (see Second Annual Report, page 81).

Plat No. 0, . . .	Thrown out of the experiment.
Plat No. 1, . . .	Twenty-five pounds of sodium nitrate (= to 4 lbs. of nitrogen).
Plat No. 2, . . .	Nothing.
Plat No. 3, . . .	Thirty pounds of dried blood (= to 4 lbs. of nitrogen).
Plat No. 4, . . .	Nothing.
Plat No. 5, . . .	Twenty-five pounds of ammonium sulphate (= to 5 lbs. of nitrogen).
Plat No. 6, . . .	Nothing.
Plat No. 7, . . .	Fifty pounds of dissolved bone-black (= 8 5 lbs. of available phosphoric acid).
Plat No. 8, . . .	Nothing.
Plat No. 9, . . .	Twenty-five pounds of muriate of potash (= from 12 to 13 lbs potassium oxide).
Plat No. 10, . . .	48½ pounds potash-mágnesia sulphate (= to 12–13 lbs. potassium oxide).

The growth on the entire field was cut September 5, and the product of each plat stacked by itself in the field for drying; it was housed October 10, with the following results: —

1885.

PLAT.	Amount of Dry Corn Fodder Obtained.	Fertilizer Applied.
No. 1, . .	480 lbs.	25 lbs. of sodium nitrate (= 4 lbs. of nitrogen).
2, . .	310 "	Nothing.
3, . .	350 "	30 lbs of dried blood (= 4 lbs. of nitrogen).
4, . .	300 "	Nothing.
5, . .	360 "	25 lbs. of ammonium sulphate (= 5 lbs. nitrogen).
6, . .	–	Fallow.
7, . .	280 "	50 lbs. of dissolved bone-black (= 8.5 lbs. available phosphoric acid).
8, . .	250 "	Nothing.
9, . .	945 "	25 lbs. of muriate of potash (= from 12 to 13 lbs. potassium oxide).
10, . .	845 "	48½ lbs. potash-magnesia sulphate (= from 12 to 13 lbs. of potassium oxide).

Comparing these results with those obtained in the previous year, where the produce of the various plats was practically of a corresponding weight (458 lbs. each), it was noticed that the application of potash compounds alone, muriate of potash leading (see Plats No. 9 and 10), had exerted a marked effect on the quantity and the quality of the corn fodder raised, increasing the previous annual yield not less than one hundred per cent. above that of the preceding year (1884).

The amount of corn fodder raised on Plat No. 1, which received nitrate of soda, had exceeded but slightly (22 lbs.) that of the previous season; while the application of blood, ammonium sulphate and phosphoric acid had not prevented a considerable falling off. The yield of corn fodder of fertilized and unfertilized plats was practically the same in most instances.

In sight of these facts, it seemed but justifiable to conclude that a deficiency of the soil in available potash had controlled, in our case, more than that of any other essential article of plant food, — the final yield of the crop.

As the cultivation of grasses and fodder corn affects the manurial resources of the soil in a similar direction by abstracting approximately one part of phosphoric acid to four parts of potash, it is but a natural result that a soil which originally did not contain much more of available potash than of available phosphoric acid must become unproductive before the latter is exhausted. In case circumstances necessitate a direct succession of these two crops, it is well to remember that fact, and to provide against a failure by applying to the soil liberally, in particular, potash compounds in some form or other. Muriate of potash deserves recommendation.

To verify the above conclusion, the experiment was continued during the past season (1886), with the sole modification of increasing on each fertilized plat the particular fertilizing ingredients to twice the amount used in the preceding year.

The plats were thoroughly plowed and harrowed May 15, 1886. The fertilizers were sown broadcast in each case, and slightly harrowed in before planting the corn, in rows, May 21 and 22 (Clark's variety). The rows were three feet three inches apart. The seeds were dropped from twelve to fourteen

inches apart and six to eight kernels in a place. The young plants appeared uniformly and healthy looking in all plats June 1. They turned, however, into a pale green color by June 28, with the exception of those on Plats 9 and 10. The latter were still of a dark green color September 11, when the entire crop was cut and stooked in the field. The corn growing on Plats 1 to 8 inclusive had reached at the end of the season a height of from two to four feet, and showed only here and there a partially filled ear; it was badly dried up and unhealthy looking when cut. The plants grown upon Plats 9 and 10 had reached a height of from five to eight feet; the stalks and leaves were still succulent when cut, and the ears pretty well formed throughout the plats, but small, and the kernels scarcely beginning to glaze.

The weight of the corn fodder raised upon each plat was ascertained October 23, when the crop was housed. The subsequent tabulated statement contains the results of the experiments. The weights of the corn fodder are stated with reference to the same state of moisture (from 45 to 50 per cent.) as in the preceding year, to allow a comparison of the results.

1886.

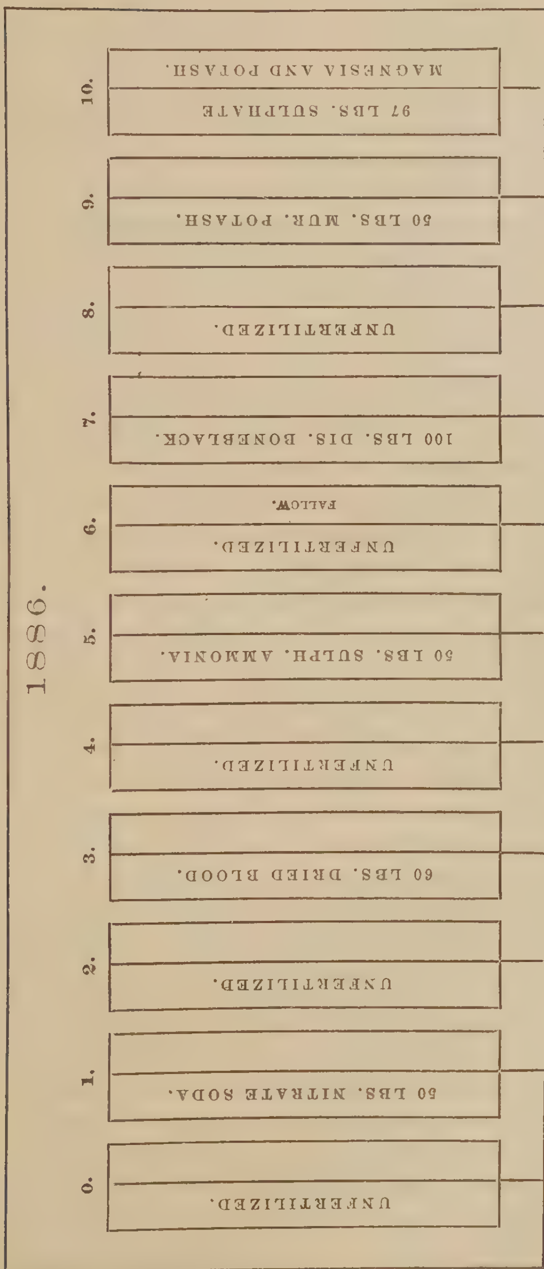
PLAT.	Amount of Dry Corn Fodder Obtained.	Fertilizer Applied.
No. 1, . .	430 lbs.	50 lbs. of sodium nitrate (=7–8 lbs. of nitrogen).
2, . .	250 "	Nothing.
3, . .	310 "	60 lbs. of dried blood (=7–8 lbs. of nitrogen).
4, . .	250 "	Nothing.
5, . .	280 "	50 lbs. of ammonia sulphate (=10 lbs. of nitrogen).
6, . .	–	Fallow.
7, . .	255 "	100 lbs. of dissolved bone-black (=17 lbs. available phosphoric acid).
8, . .	195 "	Nothing.
9, . .	840 "	50 lbs. of muriate of potash (=25 lbs. of potassium oxide).
10, . .	895 "	97 lbs. of potash-magnesia sulphate (=25 lbs of potassium oxide).

These results, compared with those of the previous year, show still a falling off in yield in all plats, notwithstanding a decided

increase of the various single manurial substances applied on Plats 1, 3, 5, 7, 9 and 10. The yield of the fertilized Plats 1, 3, 5, 7 during the last season (1886) is less than that of the unfertilized plats in 1885. The good service of potash compounds in our case is still remarkable.

The experiment will be continued, with some modifications, during the coming season.

"FIELD A."



Corn Plats with Drainage System. Scale, 4 rods to 1 inch.

2. Fodder Corn and Corn Ensilage.

The last annual report on the work of the Experiment Station contains upon pages 52 and 53 a record of observations concerning the gradual increase of vegetable matter in the fodder corn during its successive stages of growth. A series of tests carried out with plants taken from our fields had demonstrated the fact that the vegetable matter in the variety of corn on trial (Clark) had increased from fifty to one hundred per cent. in actual weight, between the time of the first appearance of the tassel and the beginning of the glazing of the kernels. It was found that the same variety of corn, raised under fairly corresponding circumstances, as far as the general character of the soil and the mode of cultivation are concerned, contained in one hundred weight parts at the time of the first appearance of the tassel from twelve to fifteen weight parts of dry vegetable matter, and from eighty-five to eighty-eight parts of water; whilst at the time of the beginning of the glazing of the kernels the former was noticed to vary from twenty-three to twenty-eight weight parts, and the water from seventy-seven to seventy-two. These results of our investigation left no doubt about the fact that our green fodder corn at the time of the beginning of the glazing of the kernels contained nearly twice as much vegetable matter per ton weight of corn as at the time of the appearance of the tassels.

This feature in the change of the composition of the fodder corn during its growth is not an exceptional one; similar changes are noticed in all our farm plants. Our observations in this direction were reported for the purpose of furnishing some more definite numerical values for the consideration of our practical farmers. As long as the vital energy of an annual plant is still essentially spent in the increase of its size, as a rule but a comparatively small amount of valuable organic compounds, as starch, sugar, etc., accumulates within its cellular tissue. The comparative feeding value of the same kind of fodder plants, or any particular part of such plants, is not to be measured by its size, but by the quantity of valuable organic nitrogenous and non-nitrogenous constituents stored up in its cellular system. The larger or smaller amount of dry vegeta-

ble matter left behind from a given weight of samples of the same kind of a fodder plant of a corresponding stage of growth indicates in the majority of cases their respective higher or lower economical value for feeding purposes. Agricultural chemists, for this reason, usually begin their examination of fodder plants with a test for the determination of the amount of dry vegetable matter left behind, when carefully brought to a constant weight at a temperature not exceeding 110° C.

The taller varieties of corn are not necessarily the more valuable kinds for the production of fodder; on the contrary, it would be more judicious, on general principles, to doubt their superior fitness for that purpose until otherwise proved. This statement applies, in particular, to some varieties recently transferred to our section of the country; for they seem to require an exceptionally rich soil to yield the best results they are represented to be capable of producing. Raised in a soil of moderate resources of plant food, little of the latter can be left over, after the production of their tall stocks and bulky leaves, to assist in the formation of valuable organic compounds, as sugar, starch, fat, nitrogenous matter, etc., to enrich the entire plant. The same mode of reasoning applies to the raising of exceptionally large-sized roots, potatoes, etc.; they are usually but partly matured, and thus of a watery, indifferent taste.

The general character of the climate and the physical and chemical condition of the soil control the local adaptation of a plant for successful cultivation. Extremes of season and one-sided modes of manuring are apt to modify the growth of a plant and thereby alter its composition. To learn how to check an inherent tendency of a plant to a rank growth, in the interest of a fairer chance for a complete maturity of the final crop, is most desirable information to secure; for success in that direction insures not unfrequently a superior pecuniary return. A careful study of the special characteristics of the plant on trial under the influence of existing local resources of the soil and of the prevailing local features of the weather during the growing season alone, can furnish a safe guide for the attainment of the desired end.

The determination of the relative feeding value of different samples of the same kind of plants raised under different cir-

cumstances is always carried out with plants of a corresponding stage of growth. Progress in the growth of plants alters their composition in regard to the quantity of vegetable matter which they contain in a given weight; it also changes very materially the absolute and relative proportion of their essential food constituents, *i. e.* their nutritive value.

The amount of vegetable matter in a given weight of green fodder corn cut at the beginning of the glazing of the kernels is known to be not only nearly twice as large as compared with that contained in an equal weight of green fodder corn cut when just showing the tassels, it is also known to be pound for pound more nutritious, for it contains more starch, more sugar, more of valuable nitrogenous matter, etc.

Considering the previously stated views correct, we filled our silos during last autumn with fodder corn, which had just reached the point where the kernels began to glaze over, expecting to secure an ensilage of superior feeding value. The results of our experiments in that direction have been very satisfactory, and may be summed up as follows: —

1. The course adopted for the production of corn fodder for the silo secures the largest amount of valuable matter which a given area of land planted with fodder corn can produce under corresponding circumstances, as far as land and season are concerned.

2. The ensilage of a more matured fodder corn has a higher feeding value, pound for pound, than that cut at an earlier stage of growth.

3. The more matured fodder corn, on account of a harder texture, is less crushed by close packing, and consequently better resists the peculiar influences which tend to deteriorate and ultimately destroy the contents of the silo.

As a more detailed description of the products of our silo may not be without some interest to our readers at this period of the season, we publish below the essential part of our results, beginning with an abstract from our late annual report, which relates briefly the course pursued in filling the silo.

The corn fodder, when cut for the silo, September 3 and 4, began to acquire a slightly yellowish tint along the outside of the field, yet was still green and succulent in the interior parts;

the kernels were soft, their contents somewhat milky, and their outside just beginning to glaze.

Corn Ensilage.— Two silos of the same size, five by fourteen feet, inside measure, and eleven feet deep, were used for the experiment. In both instances the corn was cut into pieces from one and one-quarter to one and one-half inches in size; they were, however, filled in a different way.

Silo No. 1 was loosely filled, September 4, to about two-thirds of its height, and the mass merely levelled without treading down. It was left in this condition without covering until September 7, at 8 o'clock A. M. At this time it had settled from eighteen to twenty-four inches; the odor of acetic acid became slightly perceptible, and the pieces of cornstalk, although sweet to the taste, showed an acid reaction to the test-paper (litmus).

Sept. 7, 8 A.M.	Temperature at 12 inches depth,	147°, 145°, 147° F.
" 8, 8 A.M.	" " 12 " "	141°, 145°, 145° F.
" 8, 8 A.M.	" " 24 " "	136.5° F.
" 8, 8 A.M.	" " 30 " "	114° F.
" 8, 8 A.M.	" " 36 " "	107° F.

As the temperature remained practically at a standstill, the filling in of more fresh-cut corn was resumed, and the silo completely yet loosely filled, September 8. A maximum registering thermometer was buried in the mass at a depth of two feet from the surface, and light boards loosely laid over the top.

Sept. 10, 8 A.M Temperature at 12 inches depth, 129 , 127° F.

The mass had now settled eighteen inches.

Sept. 11, 8 A.M.	Temperature at 12 inches depth,	127°, 129°, 131° F.
" 12, 8 A.M.	" " 12 " "	122°, 132° F.

The mass had settled from twenty-four to thirty inches. The temperature remained practically the same; the mass was carefully covered with tarred paper and tight-fitting boards, and subsequently, on September 12, pressed down with twenty-five barrels of sand. This silo contained about eight tons of green corn fodder.

The temperature observations above recorded were made in different parts of the silo; they show that it is quite difficult to secure a desirable uniform temperature within the mass in all parts of the silo, at the same depth and at the same time.

Silo No. 2 was filled to a depth of from eight to nine feet, as fast as the cut corn could be supplied and tramped down. As soon as the amount of corn assigned for that silo (9.5 tons) was filled in, the surface was carefully covered with tarred paper and tight-fitting boards, in the same manner as in case of the first silo, and at once pressed down with twenty-five barrels of sand. A maximum registering thermometer was safely buried at a depth of about two feet in the mass, to record the highest temperature which the latter would reach during the time of keeping the silo closed.

The silo had been closed about six months when opened. The highest temperature recorded by the thermometer buried at a depth of two feet below the surface of the ensilage, after closing the silo, was 116.5° F.

A layer of eighteen inches in thickness on the top, and from six to eight inches along the sides, was of dark color and unfit for fodder. It was removed until no mould could be noticed on the leaves and stem parts; the ears of the corn were best preserved. The main bulk of the ensilage was of a brownish yellow color, and showed a decided acid reaction to the test-paper. The odor was at first that of organic matter slowly disintegrating under the exclusion of air, but changed soon after the opening of the silo into that of acetic acid (vinegar). The free organic acids contained in one hundred weight parts of the fresh ensilage (directly after the opening of the silo) required 1.309 parts of sodium hydroxide for their neutralization, which is equal to 1.96 per cent of acetic acid. The same quantity of fresh ensilage contained 0.0374 parts of actual ammonia. No starch could be detected in the stems and leaves, whilst an abundance of it was found in the ears.

CORN ENSILAGE.

[Taken from Silo No. 1, March 23, 1886.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	78.05	1,561.00	–	–	1 : 12.2
Dry Matter,	21.95	439.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	3.16	63.20	–	–	
" Cellulose,	20.48	409.60	294.91	72	
" Fat,	3.84	76.80	57.60	75	
" Protein (Nitrogenous Matter),	7.37	147.40	107.60	73	
Non-nitrogenous Extract Matter,	65.15	1,303.00	873.01	67	
	100.00	2,000.00	1,333.12	–	

Silo No. 2 was opened seven months after being filled. A layer about six inches in thickness had to be removed from the top and the sides of the contents of the silo to reach an acceptable fodder for cows. The highest temperature registered by the thermometer since its introduction into the silo at a depth of two feet at the time of closing was 97.8° F.

CORN ENSILAGE.

[Taken from Silo No. 2, April 25, 1886.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	76.90	1,538.00	–	–	1 : 10.4
Dry Matter,	23.10	462 00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	5 22	104.40	–	–	
" Cellulose,	17.67	353.40	254.45	72	
" Fat,	3.15	63.00	47.25	75	
" Protein (Nitrogenous Matter,	8.27	165.40	120.74	73	
Non-nitrogenous Extract Matter,	65.69	1,313.80	880.25	67	
	100.00	2,000.00	1,302.69	–	

The main body of the ensilage was in fine condition, of a yellowish green color, somewhat lighter than in silo No. 1. It had a slightly acid smell and taste. To neutralize the free organic acids contained in one hundred weight parts of fresh ensilage, collected at the opening of the silo, required 1.130 parts of sodium hydroxide, which is equal to 1.95 per cent. of acetic acid. The amount of ensilage contained 0.027 parts of actual ammonia.

A comparison of these observations with those made in connection with the contents of No. 1 shows that in our case the direct filling and closing of the silo produced the best results. The contents of the silo filled at once with cut corn-fodder, and subsequently carefully closed up, had suffered less serious alteration in various directions than those that had passed through a previous heating process, in consequence of a longer exposure to atmospheric agencies. The records of the thermometers, the chemical analyses of the ensilage from both silos, and the general character of both kinds of ensilage confirm our above conclusion. Adding to these statements the circumstance that our cows decidedly preferred the ensilage from silo No. 2, we feel that we can recommend the course pursued in filling that silo. As the free acids, acetic and lactic, in a corn ensilage, however carefully prepared, steadily increase after the opening of the silo, as long as unchanged saccharine and amylaceous constituents (sugar and starch) are present, it is very important that the access of air should be limited as far as practicable. The decision in regard to the best size of the silo should be largely controlled by the possible rate of consumption. The feeding value of the contents of the most carefully packed silo is apt to be most seriously impaired in consequence of a subsequent prolonged exposure to the air. Three to four weeks' exposure altered the character of our ensilage seriously, as far as its acidity was concerned. The degree of the change depends, under corresponding circumstances, largely on the surrounding temperature. It is far less during the winter months than in April or May.

Analyses of Corn and Cob before and after their Treatment in a Silo.

[1. Corn and cob; cured naturally in the field. 2. Whole corn and cob; from silo. 3. Cut corn and cob; from silo.]

	Per Cent.		
	1	2	3
Moisture at 100° C.,	10.71	25.50	50.27
Dry Matter,	89.29	74.50	49.73
	100.00	100.00	100.00
Analyses of Dry Matter.			
Crude Ash,	2.16	1.43	1.35
" Cellulose,	5.39	8.32	8.50
" Fat,	5.27	8.66	7.84
" Protein (Nitrogenous Matter),	12.18	10.56	6.63
Non-nitrogenous Extract Matter,	75.00	71.03	75.68
	100.00	100 00	100.00

The material which served for the above analyses was sent on for that purpose during the month of September, 1886, with the following statement: The different samples were taken from the same lot of corn eleven months ago. The crop was cut when the ears began to glaze. No. 1, whole ears, was removed from the stalks and dried in the usual way on the ground'; No. 2, whole ears, was buried at the same time in the silo about six feet below the surface of the cut material, which consisted of the cut stalks and cut ears; No. 3 consisted of pieces of cut ears of corn taken from the main bulk of corn ensilage at the same time when sample No. 2 was removed for an examination, about eleven months after the filling of that silo. The samples were collected for the purpose of ascertaining the character and the degree of change which the ear of the corn undergoes by converting it into ensilage, either whole or when cut into pieces. A comparison of the analytical results shows, what might be expected, that cut ears of corn are liable to suffer a more serious alteration in their composition than whole ears.

Analyses of Rowen.

[1. Sun-dried in the field. 2. After being in a silo eleven months.]

	Per Cent.	
	1	2
Moisture at 100° C.,	19.71	18.44
Dry Matter,	80.29	81.56
	100.00	100.00
Analysis of Dry Matter.		
Crude Ash,	8.99	8.76
" Cellulose,	29.43	27.93
" Fat,	4.96	6.98
" Protein (Nitrogenous Matter),	14.70	12.34
Non-nitrogenous Extract Matter,	41.92	43 99
	100.00	100.00

These analyses point in the same direction as the previous ones. The reduction of nitrogenous matter as compared with that of the non-nitrogenous extract matter is most noticeable; yet this circumstance does not represent the entire loss in organic matter. The decrease in crude cellulose and the increase in crude fat both confirm that statement. To state with more exactness the loss of organic matter in cases like those under consideration, requires a more definite knowledge regarding the amount of dry matter contained in the fresh rowen, and of the average moisture of the various layers of rowen in the silo. None of our ordinary modes of preserving fodder is without the liability of losses; it remains in most instances a matter of degree, depending quite largely on circumstances beyond the control of the farmer. Succulent plants are most likely to suffer seriously in the ordinary drying process, and it is for this reason that the silo system deserves, in particular, a careful consideration for the efficient preservation of these crops.

ENSILAGE MADE FROM APPLE POMACE.

[Amherst Mill.]

	Per cent.
Moisture at 100° C.,	85.33
Dry Matter,	14.67

Analysis of Dry Matter.

Crude Ash,	4.21
" Cellulose,	22.18
" Fat,	7.36
" Protein (Nitrogenous Matter),	8.22
Non-nitrogenous Extract Matter,	58.03
	100.00

The pomace which served for the preparation of the apple ensilage was taken from a cider-mill near Amherst towards the close of October, 1885, and consisted of the clear press refuse of a mixture of different kinds of apples.

Two casks, of a capacity of from fifty to sixty gallons each, were used for the experiment. They were painted inside with a black tar varnish to render them air and water tight. The pomace was stamped down solid, and subsequently covered with tar paper, which was held down by a layer of sand several inches in thickness, and some large stones. The casks, thus filled, were kept in a corner on the barn-floor until May 17, 1886, when they were opened to examine their contents. The material was found throughout apparently as fresh as when put up; neither mouldy, rotten, or even discolored on its surface. It had a pleasant fruit-like acid odor and taste, and contained but traces of ammonia compounds. One hundred parts of the fresh apple ensilage required 0.744 parts of sodium hydroxide for the neutralization of its free organic acids, which prove thus to be less than in either kind of corn ensilage. The ensilage of apple pomace is highly relished by cows and swine, and is, if not superior, at least equal, pound for pound, in feeding value to the apple pomace, which served for its production. The nitrogenous constituents had increased at the expense of the saccharine constituents; the latter had been destroyed at a higher rate by fermentation than the former.

3. Influence of Fertilizers on the Quantity and the Quality of some Prominent Fodder Crops.

[Field B.]

The land selected for the experiment had been used, for several years previous, for the production of hay. At the beginning of the season of 1883 it had been ploughed and planted with corn, without the addition of any fertilizer. The soil consisted of a good sandy loam, and was, in consequence of its previous treatment, in a suitably impoverished condition to respond to the application of fertilizers.

The entire field, consisting at that time of one and one-tenth of an acre, was subdivided into plats, each one-tenth of an acre in size. Every alternate plat was fertilized at the rate of six hundred pounds of ground, rendered bones, and two hundred pounds of muriate of potash, per acre. The fertilizer was applied a few days before seeding, and slightly harrowed under.

The experiment in 1884 comprised four standard grasses, i. e., Orchard grass (*Dactylis glomerata*), Meadow fescue (*Festuca pratense*), Timothy (*Phleum pratense*) and Redtop (*Agrotis vulgaris*), besides two Millets, Hungarian grass (*Panicum Germanicum*) and Pearl millet (*Penicillaria spicata*), and one variety of corn, Clark. (See sketch of Field B, 1884–1885.)

The plats Nos. 11, 13, 15, 19 and 21 were fertilized; and Nos. 12, 14, 16, 18 and 20 received no manurial matter of any description.

In the case of the grasses and millets, each plat was again subdivided into two, and each half seeded down with one distinct kind of grass seed as follows: —

Plat 11 (fertilized), ...	Orchard Grass (north side), Meadow Fescue (south side).
Plat 12 (unfertilized), ...	Orchard Grass (north side), Meadow Fescue (south side).
Plat 13 (fertilized), ...	Hungarian Grass (north side), Pearl Millet (south side).
Plat 14 (unfertilized), ...	Hungarian Grass (north side), Pearl Millet (south side).

Plat 15 (fertilized), ...	Timothy (north side), Redtop (south side).
Plat 16 (unfertilized), ...	Timothy (north side), Redtop (south side).
Plat 17 (fertilized), ...	Corn (Clark).
Plat 18 (unfertilized), ...	Corn (Clark).
Plat 19 (fertilized), ...	Corn (Clark).
Plat 20 (unfertilized), ...	Corn (Clark)
Plat 21 (fertilized), ...	Corn (Clark).

RESULTS OF EXPERIMENTS WITH CORN.

Analysis of Green Fodder Corn.

		Plat 17. (Fertilized.)	Plat 18. (Unfertilized.)
1884.			
July 25. At the beginning of Blooming,	Moisture at 100° C., .	87.62	85.15
	Dry Vegetable Matter,	12.38	14.85
Sept. 1. Kernels in Milk,	Moisture at 100° C., .	72.27	78.77
	Dry Vegetable Matter,	27.73	21.23

Fertilized Plats, $\frac{1}{10}$ of an acre each, .	Plat 17, 4,340 lbs. Plat 19, 3,096 lbs.	Total yield, 7,436 lbs.
Unfertilized Plats, $\frac{1}{10}$ of an acre each, .	Plat 18, 2,460 lbs. Plat 20, 2,556 lbs.	Total yield, 5,016 lbs.

Yield of Fertilized Plats, per acre, ...	37,180 lbs.
Yield of Unfertilized Plats, per acre, ...	25,080 "
Difference in yield, ...	12,100 lbs.

Composition of Dry Vegetable Matter in Corn Fodder (fertilized).

Crude Ash, ...	3.16 parts.
Crude Cellulose, ...	24.32 "
Crude Fat, ...	2.89 "
Crude Protein, ...	9.64 "
Non-nitrogenous Extract Matter, ...	59.99 "

During the year 1885, plats Nos. 17, 18, 19, 20 and 21 served again, as in previous years, for the cultivation of corn. The crop raised upon the fertilized plats Nos. 17, 19 and 21 was used in part for ensilage; that obtained from the unfertilized plats Nos. 18 and 20 was sold as dry fodder corn; both crops were cut at the same time to compare results.

The entire crop upon all plats was cut Sept. 4, 1885. The dry corn fodder secured from the fertilized plats averaged $5\frac{1}{6}$ tons per acre, and that from the unfertilized plats in this connection yielded $3\frac{1}{10}$ tons for the same area. The fertilized plat No. 13 produced 1,870 pounds of dried millet, or 18,700 pounds ($9\frac{1}{3}$ tons) per acre; and the unfertilized plat No. 14 (for three succeeding years without manure) produced 1,050 pounds of air-dried crops, or 10,500 pounds ($5\frac{1}{4}$ tons) for a corresponding area.

The plats 11, 12, 15 and 16 (Field B), which had been seeded down broadcast, during the month of September, 1884, with several varieties of grasses for the purpose of studying their individual nutritive character at different successive stages of growth, became soon infested with all kinds of plants. As this circumstance could not otherwise than quite seriously interfere with our object, it was thought best to replough these plats and *to seed* down again *each variety* of *grass*, *in drills*. The cultivation of grasses in drills, two feet apart, was adopted with much success June 22, 1885. A frequent use of the cultivator, aided by the hoe and the weeding by hand, has enabled us to secure a suitable material for examination during last summer, 1886.

No material changes have been made of late in the general arrangement and mode of treatment of the plats in Field B, beyond the addition of an area of forty-three feet in length and of a corresponding width of the existing plats on the west end of each individual plat. This addition makes the present length of these plats 175 feet; they are each 33 feet wide (see sketch of Field B in 1886). The same varieties of grasses and of corn (Clark) were cultivated. The latter was also planted, in place of two varieties of millets during the preceding year, in plats 13 and 14. The corn was planted, as in previous years, in drills three feet three inches apart; the seed was dropped, from six to eight in a place, at a distance of from twelve to fourteen inches apart, May 17, 1886. Plats 13, 17, 19 and 21 were fertilized with ground bones and potash, as in preceding years, while plats 14, 18 and 20 received no manurial matter of any description. The growth of the corn on fertilized and unfertilized plats presented throughout the season a similar appearance, as has been noticed and described on previous occasions,

with the exception of the fertilized plat 13 and the unfertilized plat 14, which yielded a larger return than any other of the plats under a corresponding treatment. These two plats had been changed from the cultivation of corn in 1883 to that of millet in 1884 and 1885. They were evidently left in a better condition for the raising of fodder corn in 1886 than the remaining plats which had been used for the production of fodder corn, without any interruption since 1883.

The corn on all plats was cut September 9 and 10, when the kernels began to glaze. The produce of the fertilized plats 13, 17, 19 and 21 was turned into corn ensilage, and that of the unfertilized plats 14, 18 and 20 was stooked in the field until October 12, when it was housed in common with the dried fodder corn obtained from the under-drained plats of Field A, described in the previous pages.

Amount of Green Fodder Corn obtained on Fertilized Plats per Acre.

Plat 13.	Green fodder corn for silo,	35,410 lbs., or	17.75 tons.
Plat 17.	" " "	27,310 "	13.65 "
Plat 19.	" " "	28,290 "	14.15 "

Amount of Dry Fodder Corn obtained on Unfertilized Plats per Acre.

Plat 14.	Dry fodder corn,	6,200 lbs., or	3.1 tons.
Plat 18.	" "	4,500 "	2.25 "
Plat 20.	" "	3,000 "	1.5 "

The grasses upon plats 11, 12, 15 and 16 looked well in the spring. The difference in their general appearance, between the fertilized plat 11 and the unfertilized plat 16, and the unfertilized plat 12 and the fertilized plat 15, was less marked than in the case of the corn; it became, however, quite striking as the season advanced. The growth upon the fertilized plats was in each case denser, taller and of a deeper color at the time of cutting for hay than for rowen. The Orchard grass was in bloom from four to five days earlier (June 7) than the Meadow Fescue (June 12). The Timothy (Herd's grass) bloomed June 28, about one week earlier than the Redtop, July 5. The grasses on plats 11 and 12 were cut July 5, and those on plats 15 and 16 July 11.

The fertilized plat 11 yielded 560 lbs. of hay (Orchard and Fescue).
The unfertilized plat 12 yielded 510 lbs. of hay (Orchard and Fescue).
The fertilized plat 15 yielded 690 lbs. of hay (Timothy and Redtop).
The unfertilized plat 16 yielded 550 lbs. of hay (Timothy and Redtop).

From this statement it will be noticed that —

Plat 11	yielded	hay	at the	rate of	2.1	tons	per acre.
Plat 12	"	"	"	"	1.9	"	"
Plat 15	"	"	"	"	2.59	"	"
Plat 16	"	"	"	"	2.06	"	"

The result is remarkable, considering that the rows of grass were two feet apart, leaving thus one-half of the area of the land unoccupied by the crop. The second growth (rowen) was not less satisfactory than the first; it was cut September 13 and 14.

The fertilized plat 11 yielded 225 lbs. of rowen (Orchard and Fescue).
The unfertilized plat 12 yielded 185 lbs. of rowen (Orchard and Fescue).
The fertilized plat 15 yielded 230 lbs. of rowen (Timothy and Redtop).
The unfertilized plat 16 yielded 175 lbs. of rowen (Timothy and Redtop).

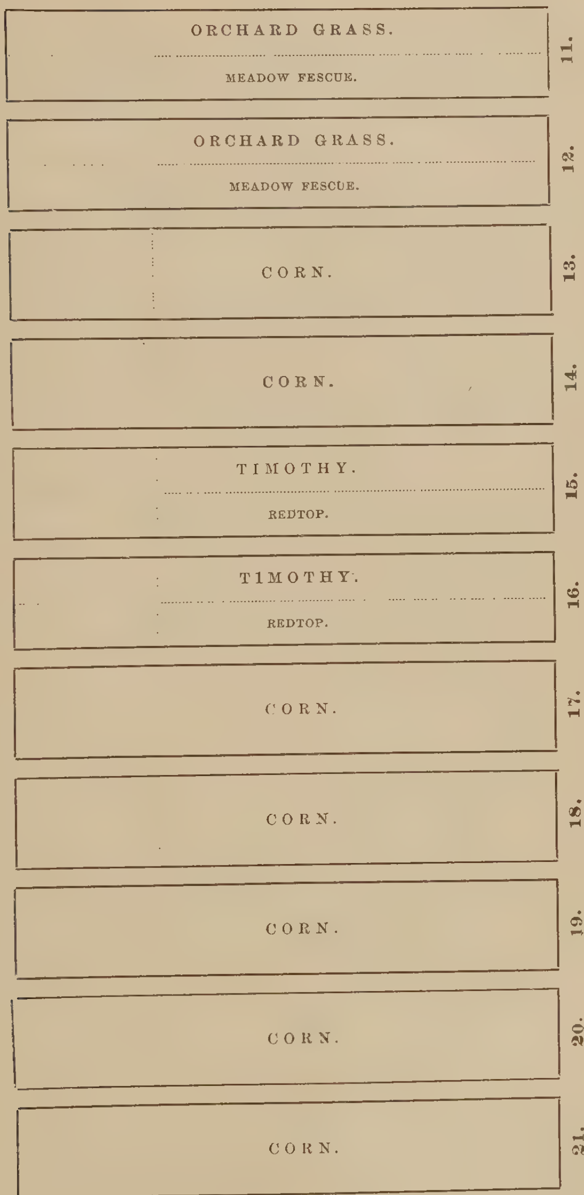
It may be seen from this that —

Plat 11	yielded	rowen	at the	rate of	.84	tons	per acre.
Plat 12	"	"	"	"	.69	"	"
Plat 15	"	"	"	"	.86	"	"
Plat 16	"	"	"	"	.65	"	"

The cultivation of grasses in drills renders a satisfactory harvesting of the crop quite troublesome, on account of the liability of a large admixture of soil in the dried crop under ordinary modes of management.

Samples of the various kinds of grasses on trial have been collected at successive stages of their growth to ascertain their respective relative nutritive value. The results of these analytical-chemical investigations will be published as soon as the work has sufficiently advanced to admit of an intelligent presentation.

FIELD "B," IN 1886.



Corn and Grass Plats. Scale, 4 rods to 1 inch. 1886.

The dotted line indicates the addition made to the original are of one-tenth of one acre in each plat during the fall of 1885.

4. Experiments with the Cultivation of Fodder Crops to furnish a Continuous Supply of Suitable Green Fodder for Dairy Stock during the Summer Season.

[Field C.]

The experiment was planned chiefly for the purpose of ascertaining the area required for the cultivation of each of the following crops, oats, vetch, serradella and Southern cow-pea, when serving in the stated succession as green fodder for the support of a definite number of milch cows, from the beginning of July to the middle of September. These crops, which have been already described more or less in detail in previous reports, were noticed to attain upon our grounds a suitable state of growth for feeding purposes at such succeeding periods of the season as promised to meet the requirements of the object in view. The feeding of each crop began when it had reached the stage of blooming, and it was discontinued when it approached its maturity. Some coarse, dry fodder, consisting mainly of hay of oats cut the previous year, was fed with the green fodder, to regulate its action on the digestive organs.

The practice of raising a greater variety of valuable crops, like those previously stated, for green fodder deserves the serious consideration of farmers engaged in the dairy business; for it secures a liberal supply of healthy, nutritious fodder at a time when hay becomes scarce and costly, and when it would be still a wasteful practice to feed an imperfectly matured green fodder-corn. The frequently limited area of land fit for a remunerative production of grasses, and the not less recognized exhausted condition of a large proportion of natural pastures, makes it but judicious to consider seriously the means which promise not only to increase, but also to cheapen, the products of the dairy. A liberal introduction of reputed fodder crops into farm operations has everywhere in various directions promoted the success of agricultural industry. The field assigned for the raising of oats, vetch and Southern cow-peas was 240 feet long and 90 feet wide; it was divided into three equal parts, each 30 feet wide and 240 feet long. The serradella covered an area 85 feet long and 56 feet wide. The soil

consisted of a good loam, and was in a fair state of cultivation. The fertilizers used consisted of six hundred pounds of fine-ground bones and one hundred and fifty pounds of muriate of potash per acre. The different crops were cultivated in drills three feet three inches apart; they proved, without exception, a success.

Oats. — The variety raised in this connection was secured in our vicinity. Its particular name is somewhat uncertain; it grows quite tall, and forms thickly-leaved stems; the grain is of a good average size and weight. The oats were sown May 3; the young plants appeared May 12; they began to bloom July 5. The feeding of the green oats commenced that day, and was continued for about two weeks, until July 20, when the plants turned yellowish. Forty pounds were fed per day to each cow.

Composition of Green Fodder Oats.

	1886.		
	July 5.	July 12.	July 20.
	Per cent.	Per cent.	Per cent.
Moisture at 100° C.,	78.61	71.18	66.04
Dry Matter,	21.39	28.82	33.96

The composition of our variety of oats at the time of feeding may be inferred from the following analysis of a sample raised on the same ground in 1885 and published in the last annual report: —

HAY OF OATS.

[From Plats of Station, cut while in Milk, July 9, 1885.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.55	191.00	–	–	1 : 7.9
Dry Matter,	90.45	1,809.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	6.08	121.60	–	–	
" Cellulose,	34.32	686.40	–	–	
" Fat,	2.69	53.80	24.75	46	
" Protein (Nitrogenous Matter),	10.89	217.80	124.15	57	
Non-nitrogenous Extract Matter,	46.02	920.40	920.40	100	
	100.00	2,000.00	1,069 30	–	

Vetch (Vicia sativa).—The seed was imported to secure the same variety of vetch which had been tried here in previous years. It was sown May 14, and made its first appearance May 19. The growth was kept clean by frequent use of the cultivator. The latter was first used May 24, when the young plants had reached a height of two inches. The first signs of blooming were noticed July 6. The feeding of the green crop commenced July 20, and was continued until August 2. Twenty-five pounds were used in the daily diet per head. A second crop was cut September 13. The vetch yields a large and valuable growth, yet seems best adapted for green fodder when raised as a mixed crop with oats, barley or rye. Clear green vetch is not as much relished at the beginning by dairy cows as the mixed crop.

Composition of Green Vetch.

[July 19, 1886.]

	Per cent.
Moisture at 100° C.,	82.97
Dry Matter,	17.03

The subsequent copies of two analyses of vetch raised on our own grounds in previous years may convey some more definite idea regarding the composition of this reputed fodder crop : —

VETCH (HAY).

(VICIA SATIVA; VARIETY, ANGUSTIFOLIA.)

[I. Collected from Experimental Plats, Aug. 15, 1883, in bloom.]

I.

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	8.35	167.00	–	–	
Dry Matter,	91 65	1,833.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	7.97	159.40	–	–	
" Cellulose,	30.68	613.60	331.34	54	1:4.02
" Fat,	2.30	46.00	27.60	60	
" Protein (Nitrogenous Matter),	15.76	315.20	239.55	76	
Non-nitrogenous Extract Matter,	43.29	865.80	562.77	65	
	100.00	2,000.00	1,161.26	–	

VETCH (HAY).

[II. Collected from Experimental Plats, Sept. 3, 1883, when fully matured.]

II.

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.45	189.00	–	–	
Dry Matter,	90.55	1,811.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	8.50	170.00	–	–	
" Cellulose,	30.05	601.00	270.45	45	1:4.09
" Fat,	2.69	53.80	32.28	60	
" Protein (Nitrogenous Matter),	14.42	288.40	204 76	71	
Non-nitrogenous Extract Matter,	44.34	886.80	487.74	55	
	100.00	2,000.00	995.23	–	

Serradella (Ornithopus sativus, Brot.). — The special agricultural value of this plant has been pointed out in a previous report. The successful cultivation upon the fields of the Station in preceding years encouraged its trial as a green fodder in connection with the experiment under discussion. The seed was planted May 12; the young plants showed themselves May 20; they commenced blooming July 13. The feeding of green serradella began August 3 and was discontinued the 24th of that month. At first twenty-five pounds, and subsequently from thirty to thirty-five pounds, formed part of the daily diet of each cow on trial. The green serradella is highly relished by the dairy cows, and has evidently a very beneficial influence on the yield of milk.

Composition of Green Serradella.

[August 4, 1886.]

	Per cent.
Moisture at 100° C., ...	84.60
Dry Matter, ...	15.40

The subsequent two analyses of samples raised here in previous years are republished in this connection to show the general character of this valuable fodder plant.

SERRADELLA (HAY).

(ORNITHOPUS SATIVUS, BROT.)

[I. Obtained from plats of the Station when blooming, Aug. 14, 1883.]

I.

	Percentage Composition.	Constituents (in lbs). in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C., . .	7.20	144.00	–	–	
Dry Matter, ...	92.80	1,856.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash, ...	5.87	117.40	–	–	
" Cellulose, . . .	24.37	487.40	–	–	
" Fat, ...	2.37	47.40	28.44	60	1 : 4.72
" Protein (Nitrogenous Matter), . . .	17.85	357.00	224.91	63	
Non-nitrogenous Extract Matter, ...	49.54	990.80	990.80	100	
	100.00	2,000.00	1,244.15	–	

SERRADELLA (HAY).

[II. From plats of Station, collected Sept. 3, 1883, when fully matured.]

II.

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	8.70	174.00	–	–	1 : 5.47
Dry Matter,	91.30	1,826.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	6.46	129.20	–	–	
" Cellulose,	25.14	502.80	236.32	47	
" Fat,	2.91	58.20	29.10	50	
" Protein (Nitrogenous Matter),	15.26	305.20	183.12	60	
Non-nitrogenous Extract Matter,	50.23	1,004.60	693.17	69	
	100.00	2,000.00	1,141.71	–	

Southern Cow-pea (Dolichos?); variety, Whippoorwill Pea. — The seeds were obtained of J. Wolfenden, provision dealer, in Newbern, N. C., who kindly furnished us with seeds in previous years. The general characteristics of this valuable Southern fodder-plant have been pointed out in the Second Annual Report of the Experiment Station, 1884, pages 91–93. The seed was sown May 14; the young plants were first noticed May 25; they made slow progress until July 15, when they began to develop more rapidly; they reached, August 14, a height of from one and one-half to two feet, and formed a dense growth of deep green vines. The green cow-pea was fed from the 24th of August to the 15th of September, 1886, beginning with 24 pounds per day and increasing gradually the amount to 40 pounds in the daily diet. Several cows served in the experiments; the daily fodder rations per head were compounded in the following manner: —

Composition of Green Cow-pea.

[August 24, 1886.]

	Per cent.
Moisture at 100° C.,	83.00
Dry Matter,	17.00

COW-PEA (HAY).

(VARIETY: WHIPPOORWILL.)

[From Experimental Plats of Station; collected Aug. 1, 1883.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	9.65	193.00	–	–	1:4.74
Dry Matter,	90.35	1,807.00	–	–	
	100.00	2,000.00	–	–	
Analysis of Dry Matter.					
Crude Ash,	10.46	209.20	–	–	
" Cellulose,	22.36	447.20	210.18	47	
" Fat,	3.87	77.40	45.67	59	
" Protein (Nitrogenous Matter),	16.95	339.00	203.40	60	
Non-nitrogenous Extract Matter,	46.36	927.20	639.77	69	
	100.00	2,000.00	1,099.02	–	

The feeding of green cow-pea ceased on account of limited supply. The vines grow until late in the season; they stand our autumn weather extremely well.

Feed in Pounds per Day.

	1886.					
	June 24 to July 5.	July 6 to July 20.	July 21 to Aug. 3.	Aug. 4 to Aug. 24.	Aug. 25 to Sept. 26.	Sept. 27 to Oct. 14.
Corn Meal,	3.25	3.25	3.25	3.25	3.25	3.25
Wheat Bran,	3.25	3.25	3.25	3.25	3.25	3.25
English Hay,	20.00	–	–	–	–	8.00
Hay of Oats (1885),	–	10.00	10.00	10.00	10.00	–
Green Oats,	–	40.00	–	–	–	–
Green Vetch,	–	–	25.00	–	–	–
Green Serradella,	–	–	–	35.00	–	–
Green Cow-pea,	–	–	–	–	30.00	40.00

As our supply of hay of oats (1885) gave out at the beginning of September, a small amount of English hay was substituted. The feeding of green fodder crops with an addition of a coarse, dry fodder has a good effect on the general con-

dition of the animal. Hay of oats is best chopped for that purpose. A temporary increase of bran, oilcakes, gluten meal and fodder articles of a similar composition instead of corn meal suggests itself in this connection as an improvement on our daily fodder rations during a first trial.

Taking our mode of cultivation into consideration, it seems advisable to cultivate for the supply of one cow, for the period of time above stated, an area of from 5,000 to 5,500 square feet of oats, and from 7,000 to 7,500 square feet each of vetch, serradella and cow-pea. In case oats and vetch are to be raised as a mixed crop, 12,000 square feet might be the limit. The oats mature too rapidly to answer for more than two weeks as a green fodder.

The field (C) turned to account for the purpose described above is in a first-class condition for the cultivation of winter grains, as far as time of seeding, clean cultivation and special accumulation of plant food is concerned. Vetch, serradella and cow-pea belong to the valuable family of *Leguminosæ;* they, like the clover, enrich the soil in the interest of grain crops. A variety of wheat occupies at present the area.

An analysis of the hay of oats used in our feeding experiment has been stated on a previous page; that of English hay follows here: —

HAY.

[From Station Fields, 1885.]

	Percentage Composition.	Constituents (in lbs.) in a ton of 2,000 lbs.	Pounds Digestible in a ton of 2,000 lbs.	Per cent. of Digestibility of Constituents.	Nutritive Ratio.
Moisture at 100° C.,	8.30	166.00	-	-	1 : 9.5
Dry Matter,	91.70	1,834.00	-	-	
	100.00	2,000.00	-	-	
Analysis of Dry Matter.					
Crude Ash,	6.12	122.40	-	-	
" Cellulose,	30.19	603.80	350.20	58	
" Fat,	2.55	51.00	23.46	46	
" Protein (Nitrogenous Matter,	9.75	195.00	111.15	57	
Non-nitrogenous Extract Matter,	51.39	1,027.80	647.51	63	
	100.00	2,000.00	1,132.32	-	

5. Experiments with Potatoes.

(Var.: Beauty of Hebron.)

The experiments carried on in this connection are at present conducted for the following purpose: —

First, To study the special effect, if any, of muriate of potash and of sulphate of potash on the quantity and quality of potatoes raised by their aid as the principal potash source of plant food.

Second, To ascertain the effect of planting whole potatoes and half potatoes, on the yield of the crop.

Third, To inquire into the causes of the production of scabby potatoes.

The first two objects of inquiry have received attention since 1884; the last-mentioned one has been added to our task during the past year, at the special request of the Franklin Harvest Club. The same piece of land has been used from the beginning of our field work (1884), as far as the first and second lines of observation are concerned; whilst a separate field was chosen for studying the behavior of "*scabby* potatoes" as "*seed* potatoes." As a short description of the course pursued in previous years cannot fail to assist in a due appreciation of the results of the past season, a few essential circumstances are in this connection republished from previous annual reports.

A. — *Experiments with High-grade German Potash Salts and Ground Bones as Fertilizers.*

1884. — Three plats, each one-fifth of an acre in size, were chosen for the experiment. The land had been for years in grass, and contained quite a number of old apple trees. The majority of the latter were removed, and the turf thoroughly broken up before manuring, during the spring of 1884.

Plat 1 (west end) received one hundred and twenty pounds of ground rendered bones and thirty pounds of muriate of potash (equal to from twenty-six to twenty-seven pounds of phosphoric acid, four to four and one-half pounds of nitrogen, and fifteen to sixteen pounds of potassium oxide).

Plat 2 received no manure of any kind.

Plat 3 (east end) received one hundred and twenty pounds of ground rendered bones, and fifty-eight pounds of double sulphate of potash and magnesia (equal to from twenty-six to twenty-seven pounds of phosphoric acid, four to four and one-half pounds of nitrogen, fifteen to sixteen pounds of potassium oxide, and five to six pounds of magnesium oxide).

The fertilizers were applied broadcast, and harrowed under before planting. The potatoes were planted in rows, three feet apart and fourteen inches distant in the drills, during the first week in May, 1884. The crop was kept clean from weeds by a timely use of the cultivator.

As an additional feature of the experiment, one-half of each plat was planted with medium-sized whole potatoes; the other with half potatoes obtained from a similar size.

The vines produced by whole potatoes showed a more vigorous growth during the main part of the season than those by part of a potato. The entire field looked promising until towards the middle of August, when with the appearance of the blight the life of the stems and leaves prematurely terminated.

The crop was harvested on the 9th and 10th of September. (See results farther on.)

Analyses of Potatoes (1884).

One hundred parts of air-dried fresh potatoes contained: —

	From Plat 1.	From Plat 2.	From Plat 3.
Dry Vegetable Matter,	19.39	23.30	21.52
Water,	80.61	76.70	78.48
	100.00	100.00	100.00

A well-matured potato contains on an average, approximately, twenty-five per cent. of solid matter. The unmatured potatoes were evidently more advanced in growth, whilst those manured with muriate of potash were least advanced in that direction.

The latter, on the other hand, had the smoothest skins, and were *almost entirely free from scab, which seriously disfigured those from Plats* 2 *and* 3.

1885. — The arrangement of the field, the mode of manuring, and the variety of the potatoes raised was the same as in the preceding season. The same three plats served for the experiment, each one-fifth of an acre in size; the potatoes were planted April 27. Plat No. 1 received, as fertilizer, thirty pounds of muriate of potash and one hundred and thirty pounds of steamed fine-ground bones; Plat No. 2 received no fertilizer; Plat No. 3 was fertilized with fifty-eight pounds of potash-magnesia sulphate and one hundred and twenty pounds of fine-ground bones. The rows were three feet three inches apart, and the seed potatoes dropped from eighteen to twenty-four inches in the row. One-half of each plat was planted with medium-sized whole potatoes; one-half with half a potato in a spot. The seed potatoes used had been carefully selected from our own crop raised during the preceding season on the same plats.

The young crop was hoed June 9. The difference in the plats was quite marked July 24; plat (No. 1) with muriate of potash had the largest foliage and looked darker green than the remainder; that with potash sulphate (No. 3) looked next best. A *blight on the leaves*, which showed itself during the first week of August, prematurely terminated the experiment; the vines upon all plats died soon after. The crop was harvested August 26. (See results farther on.)

The potatoes from all the plats suffered severely from scab.

As the increase of vegetable matter in the young plant indicates the progress of their growth, it was decided to determine, from time to time, the actual amount of vegetable matter in a given weight of the more advanced tubers, by carefully expelling the water present, at a temperature of from 100° to 110° C.

A well-matured potato contains, as has been stated before, on an average twenty-five per cent. of solid matter.

The subsequent statements are the results of our examination.

Determination of Solids in Potatoes.

JULY 24.

	From Plat No. 1.	From Plat No. 2.	From Plat No. 3.
Moisture at 100° C.,	81.44	79.49	79.39
Solids,	18.56	20.51	20.61
	100.00	100.00	100.00

AUGUST 5.

	From Plat No. 1.	From Plat No. 2.	From Plat No. 3.
Moisture at 100° C.,	80.96	81.04	79.36
Solids,	19.04	18.96	20.64
	100.00	100.00	100.00

AUGUST 27.

	From Plat No. 1.	From Plat No. 2.	From Plat No. 3.
Moisture at 100° C.,	79.85	80.60	80.61
Solids,	20.15	19.40	19.39
	100.00	100.00	100.00

The exceptionally large proportion of small potatoes obtained in particular from Plats Nos. 2 and 3, as well as the low percentage of solids in the potatoes tested, prove the premature termination of a healthful condition of the entire crop. The normal growth of the tubers came apparently to a standstill soon after the first examination for solids had been made (July 24, etc.). The results seemed to indicate a connection between "blight" and "scab"; and left scarcely any doubt about the circumstance, that either the one or the other, or both jointly, had contributed directly or indirectly towards the partial failure of the crop for the two succeeding seasons.

It was decided, in sight of these facts, to continue the experiments in 1886 upon the same field, with some modifications, to ascertain, if possible, whether the main influence regarding the results in our past observation had to be ascribed to atmospheric agencies, or to the condition of the soil and to the fertilizer applied or to the quality of the seed potato used.

1886. — The same field was used. The land was well prepared by plowing and harrowing April 27, and subsequently fertilized the same as in previous years. Plat 1 received broadcast, as before, a mixture of muriate of potash and fine-ground bones. Plat 2 received, as before, no fertilizer of any description. Plat 3 was again manured broadcast, with sulphate of potash and fine-ground bones. The change, regarding the character of the fertilizer applied, consisted in using nearly twice the amount of potash salts, muriate of potash and sulphate of potash for the same area in case of Plats 1 and 3. The increase in potash compounds was made to test their efficacy as a preventative of scab. A second important change from our previous practice consisted in securing first quality seed potatoes, — in particular, *free* from scab. The same variety — Beauty of Hebron — was obtained for that purpose from Vermont; it was as fair an article as could be desired. The system of planting and cultivating was the same as in previous years. The potatoes were planted upon all plats May 5, 1886; each plat had fourteen rows, with hills three feet apart in each direction. The young plants appeared evenly; the vines coming from whole potatoes, however, soon became heavier and taller than those coming from half potatoes, a peculiarity in their growth which remained noticeable during the entire season. All the vines were in full blossom July 6; they began to turn yellowish and to dry up July 30. The crop on the entire field was dried up August 8. This change seemed to appear most marked first on the vines from whole-seed potatoes. The entire crop was harvested August 28.

The experiment of the past season has been a serious failure, as far as the *quality* of the potatoes raised on any of the three plats is concerned. The entire crop, with scarcely any exception, was badly disfigured by scab; the potatoes were unfit for family use, and had to be sold at a low price for stock feeding.

Neither a liberal use of our own mixture of commercial manurial substances, rich in potash compounds, nor the selection of a fair quality of seed potatoes from another source, has affected our results as compared with those of the previous season. The successful raising of a *superior* potato from *scabby* seed potatoes upon another field of the Experiment Station, which will be described farther on in these pages, shows that the atmos-

pheric peculiarities of the last summer season cannot have caused the above-reported failure. In sight of these circumstances it seems but natural to incline to the conclusion that some peculiar condition of the soil upon the lands occupied by this experiment has to be considered as the real seat of our trouble. The work will be continued until a more positive proof can be offered.

The subsequent tabular statement regarding certain features of the potato crops raised for three successive years upon the three experimental plats here under discussion are not without interest when considered in connection with the preceding remarks.

1884.

PLAT I.

SEED POTATO.	Fertilizer Applied.	Yield of Potatoes upon One-fifth of an Acre, in Pounds.		
		Large.	*Small.*	*Total.*
Whole Potato, .	120 lbs. ground bones and 30 lbs. muriate of potash.	1,085	460	1,545
One-half a Potato, .		1,140	335	1,485
		2,225	795	3,030

PLAT II.

		Large.	*Small.*	*Total.*
Whole Potato, .	Not fertilized.	830	280	1,110
One-half a Potato, .		850	250	1,100
		1,680	530	2,210

PLAT III.

		Large.	*Small.*	*Total.*
Whole Potato, .	120 lbs. of bones and 58 lbs. potash-magnesia sulphate.	1,120	342	1,462
One-half a Potato, .		930	105	1,035
		2,050	447	2,497

1885.

PLAT I.

SEED POTATO.	Fertilizer Applied.	Yield of Potatoes upon One-fifth of an Acre, in Pounds.		
		Large.	*Small.*	*Total.*
Whole Potato, .	120 lbs. ground bones and 30 lbs. muriate of potash.	705	355	1,060
One-half a Potato, .		695	270	965
		1,400	625	2,025

PLAT II.

		Large.	*Small.*	*Total.*
Whole Potato, .	Not fertilized.	335	350	685
One-half a Potato, .		255	270	525
		590	620	1,210

PLAT III.

		Large.	*Small.*	*Total.*
Whole Potato, .	120 lbs. of bones and 58 lbs. potash-magnesia sulphate.	605	490	1,095
One-half a Potato, .		540	580	1,120
		1,145	1,070	2,215

1886.

PLAT I.

SEED POTATO.	Fertilizer Applied.	Yield of Potatoes upon One-fifth of an Acre, in Pounds.		
		Large.	*Small.*	*Total.*
Whole Potato, .	100 lbs. ground bones and 50 lbs. muriate of potash.	410	592	1,002
One-half a Potato, .		431	188	620
		841	780	1,622

PLAT II.

SEED POTATO.	Fertilizer Applied.	Yield of Potatoes upon One-fifth of an Acre, in Pounds.		
		Large.	*Small.*	*Total.*
Whole Potato, .	Not fertilized.	321	398	719
One-half a Potato, .		353	194	545
		674	592	1,264

PLAT III.

SEED POTATO.	Fertilizer Applied.	*Large.*	*Small.*	*Total.*
Whole Potato, .	100 lbs. ground bones and 96 lbs. potash-magnesia sulphate.	747	503	1,250
One-half a Potato, .		658	315	974
		1,405	818	2,224

A careful study of the above tables leads to the following conclusions : —

1. Medium-sized whole potatoes give better results than half potatoes obtained from tubers of a corresponding size.

2. Disregarding the results of the first year, when previously existing liberal resources of plant food are apt to render the influence of an additional supply of manurial substances less marked, it appears that the sulphate of potash produced better results in our case than the muriate of potash.

3. The premature dying out of the vines, accompanied by blight or scab, or both, must be considered a controlling cause of the exceptionally large proportions of small potatoes.

B. — *Observations with Scabby Potatoes.*

These experiments were inaugurated during the past season for the purpose of inquiring into the circumstances which control the development and the propagation of the "scab" on potatoes.

The first year's work in this connection has been confined to the task of observing the behavior of scabby potatoes as *seed* potatoes, under some definite previous treatment. To prevent

a possible propagation of scab, by infected seed potatoes, to the new crop, the following course was adopted: Thoroughly scabby potatoes obtained from the previously-described experimental plats were treated with some substances known to be destructive to various forms of parasitic growth. This operation was carried out with the intention of destroying the propagating power of adherent germs of an objectionable character, before planting the potatoes.

The field for the observation was distinctly separate from other experimental plats for the cultivation of potatoes. It had been used for many years previous for the raising of grass, and had since been planted but once, — the preceding year, — with corn. The land was prepared by ploughing and harrowing, in the same way as other potato fields: it was fertilized broadcast with the same amount of fertilizer per acre as Plat No. 3, in 1884 and 1885, in the above-described experiment (A); namely, six hundred pounds of ground bones and two hundred and ninety pounds of potash-magnesia sulphate.

The field was subdivided into five plats of equal size, eighty feet long and fifty feet wide, and the potatoes subsequently planted in rows three feet three inches apart, with hills three feet from each other in the rows. Three feet of space was left unoccupied between the different plats. The scabby seed potatoes selected for the trial were, as far as practicable, of a uniform medium size. Each lot was immersed in the particular solution prepared for the different plats; after being kept there for twenty-four hours they were removed, and directly planted without any other operation.

Plat No. 1 (north end of field). The seed potatoes used in this case were smooth and healthy; they were planted without being subjected to any preparatory treatment. This course was adopted to learn whether soil, fertilizer or atmospheric agencies of the season would favor the appearance of the scab in the crop.

Plat No. 2. The potatoes were allowed to remain for twenty-four hours in a saturated solution of muriate of potash before being planted.

Plat No. 3. A strong solution of hypochlorite of lime (bleaching lime) was applied in a similar way for the preparation of the seed potatoes as in Plat No. 2.

Plat No. 4. A saturated solution of carbolic acid in water served in this instance for the treatment of the seed potatoes.

Plat No. 5. The seed potatoes used in this plat were treated, previous to planting, with a strong abstract by cold water of "The Potato Protector" of John Butterworth & Co., Mansfield, Mass. This material was sent to the Station, for an opinion regarding its merits, at a time when active preparations were under way to test by field experiments whether substances like those above stated would prove efficient to prevent the propagation of "scab" by seed potatoes. The practice of treating wheat and other seeds for similar purposes with solutions of sulphate of copper, etc., is not uncommon in other localities. As the "Potato Protector" proved to contain quite a noticeable quantity of a powerful agent, hypochlorite of lime, it was thought best to introduce the material into our experiment, instead of offering a mere opinion regarding its merits. The results of an examination into the composition of the "Potato Protector" are published with some comments at the close of this chapter.

The potatoes were planted in all plats on the same day, May 7, 1886; the young vines appeared on Plats 1 and 5, May 25, whilst on Plats 2, 3 and 4 they did not show themselves before the 29th of May, and not as generally and evenly as on Plats 1 and 5. This difference in growth could be noticed until towards the close of June, when the vines on all plats looked equally vigorous and thrifty. The vines on all the plats were, at this stage, vigorously attacked by the potato bug, and were protected against their destructive influence by a repeated sprinkling with a solution of Paris green. They began to bloom July 6. The vines on Plat 1 began first to turn yellow and to dry up July 30; those on the remaining plats began to change in a similar way August 8. The tops on all the vines were pretty generally dried up August 18. The potatoes were harvested on the entire field August 30. The yield on all plats was fair and the quality of the potatoes, almost without exception, excellent; this seemed to be most striking in regard to those from Plats 2, 3 and 4, which had been in the beginning of the season somewhat behind in growth. Here and there could be seen a potato with a small mark of scab; a large proportion were perfectly smooth and without any sign of it.

These results are recorded merely as those of a first experiment. They are, however, not without some interest when considered in connection with previous observations. The fact that a scabby potato may produce, under certain circumstances, a smooth and otherwise excellent potato must be accepted. The recognition of this fact does not, however, entitle us to the conclusion that it is a safe course to advise planting scabby potatoes with the expectation of raising a superior, healthy potato, without awaiting the results of a repetition of the experiment under modified circumstances. Good potatoes have been raised before from seed potatoes suffering from scab without any previous treatment similar to ours. Without any intention of anticipating the results of future observations, or to point out with certainty the exact cause of the results, we feel inclined to consider a difference in the condition of the soil on our old and new experimental potato plats, the real seat of our troubles; for the former yielded most inferior, scabby potatoes, whilst the latter produced a most superior, smooth potato under otherwise identical conditions as far as soil, mode of cultivation and kind of fertilizer, upon land in close proximity, during the same season.

Potato Protector.

The material consisted of a brownish mixture of organic and earthy substances, which smelled strongly of hypochlorous acid. It deflagrated violently at red heat, and left 35.40 per cent. of crude ash, which contained 12.40 per cent. of chlorine, 14.15 per cent. of calcium oxide and 0.11 per cent. of phosphoric acid, the rest being silicious matter.

A watery solution was dark-colored and smelled like a decoction of some herb, possibly the Bone-set (*Eupatorium perfoliatum*). A solution of some whitish substances it contained quickly decolorized an indigo solution.

From the above observation it appears that the substance is a mixture of some herbaceous matter with hypochlorite of lime (bleaching lime) as a prominent constituent.

The claim of the manufacturer is stated in the subsequent copy of a circular sent on with the material for our examination: —

To Farmers and Gardeners.

GENTLEMEN: — Permit me to call your attention to the remedy for the Potato Bug scourge, called "The Potato Protector."

It is non-poisonous, cheap, easy of application, and effective. It is composed mostly of vegetable substances, which are warranted not to poison man or beast. For twenty-five cents you can buy enough of it to treat one bushel of seed, and it is warranted to be a cheaper protector for the amount of land this seed will plant than a *single* application of Paris Green would be, and ordinarily a second and third application of the poison has to be made to protect the plants. But the *method of applying the Protector is its strong point.* The strength of one package of the Protector is transferred to five gallons of water, according to directions on each package; in this solution one bushel of seed potatoes, cut and ready to plant, is soaked for one-half hour. The plants from seed thus treated will be so distasteful to the bugs, both young and old, that they will not molest them, and the flavor of the Protector, so distasteful to the bugs, *is warranted not to be perceptible in the potatoes.* Thus by a single treatment, that may be done at the rate of a bushel an hour, without expensive help, the same results are secured at one-tenth the labor of applying Paris Green.

One season's trial will convince you that the Protector will keep the bugs off. The inventor, Mr. John Butterworth, after six years' experimenting, hit upon the Protector in 1884. That season it alone, of many others, stood the test, and in 1885 its value was confirmed by treating alternate hills, when the hills not treated were destroyed, and slugs and winged bugs placed on the treated hills would not feed or remain there.

JOHN BUTTERWORTH & CO.,
Mansfield, Mass.

Our experiment does not confirm the claim of the manufacturer, for potato bugs were as plenty on the vines of the potatoes treated in the above-described manner by a solution of "the Potato Protector" as on any other of our different experimental potato plats. Aside from this fact, it is but an act of justice to the manufacturer to state that he invited by letter an actual investigation on our part into his claim.

We should not, however, advise the preparation of a mixture of hypochlorite of lime, or bleaching lime, with herbaceous matter, if we did intend to turn the peculiarity of the former to account, for in that case it soon suffers serious alterations in its composition.

6. Miscellaneous Field Experiments with Farm and Garden Crops.

The field observations recorded under the above heading are made, in the majority of cases, on a comparatively limited scale. The supply of the seeds was, in many instances, quite small; some of them have been sent on by the United States Department of Agriculture in Washington, D. C. The work carried on in this connection has had, for obvious reasons, no other aim than to study either the adaptation of some new field crop to our climate, or to compare some new variety of a prominent garden crop with those frequently raised in our section of the State. The field set aside for these experiments was in a good state of cultivation. Barnyard manure, supplemented by commercial phosphates and potash compounds, had been used in the past as manure; no alteration was made in this respect during the past season. The different crops were seeded down in drills three feet three inches apart, and subsequently kept clean by a frequent use of the cultivator.

1. *Cleveland's Rural New Yorker Pea* (Pisum). — The seed was planted May 8; the young plants appeared May 17; they bloomed June 14. The first crop was ready for table use July 1. The fully matured vines had from five to six well-filled pods. Three rows forty feet long produced eight pounds of air-dried vines and six and one-half pounds of air-dried peas.

2. *Cleveland's Alaska Pea.* — The seeds were planted May 8; the young plants appeared May 19; they began to bloom June 14, and the first crop for table use was ready July 1. Each matured vine had from five to six well-filled pods. Three rows forty feet long yielded eight pounds of air-dried vines and six pounds of air-dried peas.

3. *Champion of England Pea.* — The seed was planted May 8; the young plants made their appearance May 20; they showed the first flowers June 28. The first crop for the table was ready July 15; they ceased growing August 7. Three rows forty feet long produced twenty-three pounds of air-dried vines and three and one-half pounds of air-dried peas.

4. *Marrowfat Peas.* — The seeds were planted May 8; the young plants appeared May 20; they showed their first blossoms July 5, and the first crop was ready for table use July 17; the

vines ceased growing and began dying out August 7. Three rows forty feet long yielded twenty-five pounds of air-dried vines and three and one-half pounds of air-dried peas.

The weights of the vines and peas were taken on the same day, three to four months after storing.

5. *Cleveland's Improved Valentine Beans* (Phaseolus). — The seeds were planted May 8; they appeared above ground May 22, and began blooming July 5; the beans reached their full size and the pods turned yellow August 10. The air-dried vines weighed twenty-six and one-half pounds; the air-dried beans twelve pounds.

6. *Horse Bean* (Vicia faba). — Three varieties of this fodder plant were raised during the past year with much success. A description of some varieties of this reputed fodder plant has been published in our previous report. Its adaptation to our soil, as well as its special agricultural value for green manuring, and for the production of a valuable bean for feeding purposes, has been discussed in that connection. Our attention during the past season was mainly directed towards the question, What proportion of the entire matured crop consists of straw and empty pods, and what of beans? The results of this inquiry are stated below.

Small horse bean. The seeds were planted May 12; the young plants appeared May 22; they began to bloom July 10, when two and one-half feet high; the first seeds formed August 13; the matured plants were cut and stooked September 13. Three rows forty feet long produced twenty pounds of air-dried straw and pods and twelve pounds of beans. The Jaeger bean, apparently but another name for small horse bean, yielded from the same area twenty pounds of air-dried straw and pods and fourteen and one-half pounds of air-dried beans. A larger variety of horse bean yielded, under similar circumstances, yet upon a larger area, two hundred pounds of air-dried beans and two hundred and seventy-five pounds of air-dried straw and pods, or for every ten pounds of dry beans thirteen and one-quarter pounds of dried straw and pods.

7. *Lupine.* — The white lupine (Lupinus albus) has been raised successfully for several years upon the fields of the Station. Its particular value as a green manure has been illustrated by experiment. During the last season two varieties

have been added to our experimental field for forage crops. Three varieties, the white, the yellow and the blue, are frequently cultivated by European agriculturalists. All are considered, more or less, a valuable addition to farm crops in general. The yellow variety is generally considered the most valuable of the three, for it is equally well fitted for green fodder or hay, or for green manure, and best adapted for a light, sandy soil, where clover cannot be raised with success. The seeds were planted May 12; the young plants were noticed May 22; they began blooming when two and one-half feet high, July 26; the seeds first formed August 7; the matured plants were cut September 11. The blue lupine produced three and one-half pounds of air-dried seeds to twelve and one-half pounds of air-dried stems and pods; the white and yellow varieties produced two pounds of air-dried seeds to twenty pounds of air-dried stems and pods.

Besides the above observations, small trials have also been made with the following seeds: —

Vicia villosa, } For sheep pastures.
Spergulum maximum, }
Sesame (Oil plant).
Pyrethrum roseum.
Some varieties of corn: *Pride of the North*, from Minnesota; *Browning Corn*, Springfield.
Some varieties of Texas grasses.
Alsike Clover.
Melilotus albus (Honey Lotus).
Lucerne (Alfalfa).
Some varieties of oats: *Harris Oats*, from Alabama, and *White Victoria Oats*, from Russia.
Melon Barley, from Russia.

Some of the results obtained in this connection are of sufficient interest to encourage further trials on a larger scale during the coming season. The new seeds of the varieties of oats and those of the new variety of barley especially are reserved for that purpose.

VALUATION OF FERTILIZERS, AND FERTILIZER ANALYSES.

The valuation of a fertilizer is based on the average trade value of the fertilizing elements specified by analysis. The money value of the higher grades of agricultural chemicals and of the higher-priced compound fertilizers, depends in the majority of cases on the amount and the particular form of two or three essential articles of plant food — *i. e.*, phosphoric acid, nitrogen and potash — which they contain. The valuation which usually accompanies the analyses of these goods informs the consumer, as far as practicable, regarding the cash retail price at which the several specified essential elements of plant food, in an efficient form, have of late been offered in our large markets.

The market value of low-priced materials used for manurial purposes, as salt, ashes, various kinds of lime, barnyard manure, factory refuse and waste materials of different descriptions, quite frequently does not stand in close relation to their chemical composition. Their cost varies in different localities. Local facilities for cheap transportation and more or less advantageous mechanical condition for a speedy action, exert, as a rule, a decided influence on their selling price.

The wholesale market price of manurial substances is liable to serious fluctuations; for supply and demand exert here, as well as in other branches of commercial industry, a controlling influence on their temporary money value. As farmers have only in exceptional instances a desirable chance to inform themselves regarding the conditions which control the market price, the assistance rendered in this direction by agricultural chemists charged with the examination of commercial fertilizers

cannot otherwise but benefit, ultimately, both farmers and manufacturers.

The market reports of centres of trade in New England, New York and New Jersey, aside from consultations with leading manufacturers of fertilizers, furnish us the necessary information regarding the current trade value of fertilizing ingredients. The subsequent statement of cash values in the retail trade is obtained by taking the average of the wholesale quotations in New York and Boston during the six months preceding March 1, 1886, and increasing them by 20 per cent., to cover expenses for sales, credits, etc.

These trade values, except those for phosphoric acid, soluble in ammonium citrate, were agreed upon by the Experiment Stations of Massachusetts, Connecticut and New Jersey for use in their several States for the present season.

Trade Values of Fertilizing Ingredients in Raw Materials and Chemicals.

	1886. Cents per Pound.
Nitrogen in ammonia salts,	18½
Nitrogen in nitrates,	18½
Nitrogen in dried and fine-ground fish,	17
Organic nitrogen in guano and fine-ground blood and meat,	17
Organic nitrogen in cotton seed, linseed meal, and in castor pomace,	17
Organic nitrogen in fine-ground bone,	17
Organic nitrogen in fine medium bone,	15
Organic nitrogen in medium bone,	13
Organic nitrogen in coarse medium bone,	11
Organic nitrogen in coarse bone, horn shavings, hair, and fish scraps,	9
Phosphoric acid, soluble in water,	8
Phosphoric acid, soluble in ammonia citrate,*	7½
Phosphoric acid, insoluble in dry, fine-ground fish and in fine bone,	7
Phosphoric acid, insoluble in fine medium bone,	6
Phosphoric acid, insoluble in medium bone,	5
Phosphoric acid, insoluble in coarse medium bone,	4
Phosphoric acid, insoluble in coarse bone,	3
Phosphoric acid, insoluble in fine-ground rock phosphate,	2
Potash as high grade sulphate,	5½
Potash as kainite,	4¼
Potash as muriate,	4¼

* Dissolved from two grams of phosphate, unground, by 100 cc. neutral solution of ammonia citrate, sp. gr. 1.09, in 30 minutes at 65 deg. C., with agitation once in five minutes, commonly called "reverted" or "backgone" phosphoric acid.

The above trade values are the figures at which, on March 1, 1886, the respective ingredients could be bought at retail for cash per pound in our leading markets in the raw materials, which are the regular source of supply.

They also correspond to the average wholesale prices for the six months ending March 1, plus 20 per cent in case of goods for which we have wholesale quotations. The calculated values obtained by the use of the above figures will be found to agree fairly with the reasonable retail prices in case of standard raw materials, such as —

Sulphate of Ammonia,	Dry Ground Fish,
Nitrate of Soda,	Castor Pomace,
Muriate of Potash,	Cotton Seed,
Sulphate of Potash,	Bone,
Dried Blood,	Azotin,

Plain Superphosphates.

Trade Values in Superphosphates, Special Manures and Mixed Fertilizers of High Grade.

The organic nitrogen in these classes of goods are here valued at the highest figures laid down in the trade values of fertilizing ingredients in raw materials, namely, 17 cents per pound; it being assumed that the organic nitrogen is derived from the best sources, as bone, blood, animal matter, or other equally good forms, and not from leather, shoddy, hair or any low-priced inferior form of vegetable matter, unless the contrary is ascertained.

Insoluble phosphoric acid has been valued at 3 cents, it being assumed, unless found otherwise, that it is from bone or a similar source, and not from rock phosphate. In this latter form the insoluble phosphoric acid is worth but 2 cents per pound. Potash is rated at $4\frac{1}{4}$ cents per pound, if sufficient chlorine is present in the fertilizer to combine with it to make muriate.

If there is more potash present than will combine with the chlorine, then this excess of potash will be counted as sulphate. To introduce large quantities of chlorides, common salt, etc., into fertilizers, claiming sulphate of potash as a constituent, is a practice which, in our present state of information, will be con-

sidered of doubtful merit. The use of the highest trade values is but justice to these articles in which the costliest materials are expected to be used.

In most cases the valuation of the ingredients in superphosphates and specials falls below the retail price of the goods. The difference between the two figures represents the manufacturer's charges for converting raw materials into manufactured articles. These charges are for grinding and mixing, bagging or barrelling, storage and transportation, commission to agents and dealers, long credits, interest on investment, bad debts, and finally profits.

The prices stated in this report in connection with analyses of commercial fertilizers refer to their cost per ton of 2,000 lbs., on board of car or boat near the factory or place of general distribution. To obtain the valuation of a fertilizer (*i. e.*, the money-worth of its fertilizing ingredients), we multiply the pounds per ton of nitrogen, etc., by the trade value per pound. We thus get the values per ton of the several ingredients, and, adding them together, we obtain the total valuation per ton.

The mechanical condition of any fertilizing material, simple or compound, deserves the most serious consideration of farmers, when articles of a similar chemical character are offered for their choice. The degree of pulverization controls, almost without exception, under similar conditions, the rate of solubility, and the more or less rapid diffusion of the different articles of plant food throughout the soil.

The state of moisture exerts a no less important influence on the pecuniary value, in case of one and the same kind of substance. Two samples of fish fertilizer, although equally pure, may differ from 50 to 100 per cent. in commercial value, on account of mere differences in moisture.

Crude stock for the manufacture of fertilizers and refuse material of various descriptions sent to the Station for examination are valued with reference to the market prices of their principal constituents, taking into consideration at the same time their general fitness for speedy action.

A large percentage of commercial fertilizing material consists of refuse matter from various industries. The composition of these substances depends on the mode of manufacture carried

on. The rapid progress in our manufacturing industries is liable to affect at any time, more or less seriously, the composition of the refuse. A constant inquiry into the character of the agricultural chemicals and of commercial manurial refuse substances offered for sale cannot fail to secure confidence in their composition, and to diminish financial disappointment in consequence of their application. This work is carried on for the purpose of aiding the farming community in a clear and intelligent appreciation of the substances for manurial purposes.

Consumers of commercial manurial substances do well to buy whenever practicable, on a guaranty of composition with reference to their essential constituents, and to see to it that the bill of sale recognizes that point of the bargain. Any mistake or misunderstanding in the transaction may be readily adjusted, in that case, between the contending parties. The responsibility of the dealer ends with furnishing an article corresponding in its composition with the lowest stated quantity of each specified essential constituent.

Connecticut Tobacco Stems.

[Sent on from South Deerfield, Mass.]

	Per cent.
Moisture at 100° C.,	10.65
Phosphoric acid (5 cents per pound),	0.51
Potassium oxide (4¼ cents per pound),	7.22
Calcium oxide,	3.39
Magnesium oxide,	1.12
Nitrogen (17 cents per pound),	2.65
Insoluble matter,	0.29
Valuation per 2,000 lbs.,	$14 66

The composition of the above sample corresponds well with that noticed on previous occasions. (See First Annual Report, page 103.)

The potash was almost entirely soluble in water at ordinary temperature; 6.85 parts of the entire amount present. The same feature was noticed in regard to the Havana tobacco stems.

Havana Tobacco Stems.

[Sent on from South Deerfield, Mass.]

	Per cent.
Moisture at 100° C.,	11.85
Phosphoric acid (5 cents per pound),	0 44
Potassium oxide (4¼ cents per pound),	6 62
Calcium oxide,	3.45
Magnesium oxide,	1.11
Nitrogen (17 cents per pound),	0.90
Insoluble matter,	1.35
Valuation per 2,000 lbs.,	$8 83

The amount of nitrogen in this sample of tobacco stems (Havana) is exceptionally low, about one-third of that found in other samples offered for sale in our section of the Connecticut River valley. (See Second Annual Report, page 138.) The difference in nitrogen causes the low valuation per ton, as compared with that of the preceding analysis. The sample was handed to us with the statement that it had been used for imparting the odor of Havana tobacco to other varieties. The odor had been removed apparently by a steaming process; for the mineral constituents, with the exception of the potassium oxide, corresponded fairly with those in the material described in our Second Annual Report. Farmers will do well to be careful in buying the article without stated guarantee of composition.

Hop Refuse.

[Sent on for examination from Lawrence, Mass.]

	Per cent.
Moisture at 100° C.,	80.98
Dry vegetable matter,	19.02
Nitrogen,	0.98
Calcium oxide,	0.27
Magnesium oxide,	0.10
Phosphoric acid,	0.20
Potassium oxide,	0.11
Insoluble matter,	0.63
Valuation per 2,000 lbs.,	$3 62

This refuse from breweries differs from the one previously described merely by a larger percentage of nitrogen it contains.

Supplemented by some phosphoric acid and potash it may serve in place of barnyard manure. The average barnyard manure (partly rotten) is usually stated to contain 0.5 per cent. of nitrogen, 0.26 per cent. of phosphoric acid and 0.6 per cent. of potassium oxide.

Rotten Brewers' Grain.

[Sent on for examination from Lawrence, Mass.]

	Per cent.
Moisture at 100° C.,	78.77
Dry vegetable matter,	21.23
Nitrogen,	0.72
Calcium oxide,	0.26
Magnesium oxide,	0.15
Phosphoric acid,	0 43
Potassium oxide,	0.04
Insoluble matter,	0.59
Valuation per 2,000 lbs.,	$2 71

The general character of the above-mentioned substance resembles that of barnyard manure. It contains more nitrogen and phosphoric acid, and less potash than the average barnyard manure. By increasing the latter ingredients to one-half a per cent. a fair substitute for barnyard manure may be obtained.

Glucose Refuse (dry).

[Sent on for examination.]

	Per cent.
Moisture at 100° C.,	8.10
Dry vegetable matter,	91.80
Nitrogen,	2.62
Phosphoric acid,	0.29
Magnesium oxide,	0.02
Calcium oxide,	0.18
Sodium oxide,	0.12
Potassium oxide,	0.15
Insoluble matter,	0.07
Valuation per 2,000 lbs.,	$9 33

This material consists mainly of the skins of corn; it is evidently the insoluble residual matter left behind after the conversion of the starch into glucose syrup. The manurial value of the article rests mainly on the amount of nitrogen it contains

in form of insoluble nitrogenous matter. To render it an efficient manure requires, in the majority of cases, a liberal addition of phosphoric acid and potash.

Damaged Cotton Seed Meal.

[Sent on from Greenfield, Mass.]

	Per cent.
Moisture at 100° C.,	9.90
Total phosphoric acid,	1 26
Potassium oxide,	1.21
Magnesium oxide,	0.56
Calcium oxide,	0 22
Nitrogen,	3.73
Insoluble matter,	0.20
Valuation per 2,000 lbs.,	$14 97

Analysis of Hen Manure.

[Sent on from Townsend, Mass.]

	Per cent.
Moisture at 100° C.,	8.35
Phosphoric acid,	2.02
Calcium oxide,	2.22
Magnesium oxide,	0.68
Potassium oxide,	9.94
Nitrogen in organic matter,	1.85
Nitrogen in actual ammonia,	0.28
Insoluble matter,	34.65
Valuation per 2,000 lbs.,	$10 55

The material was dry, and contained the usual mixture of feathers, short pieces of coarse vegetable matter, earthy substances, etc., yet not in an extraordinary degree. The value of the hen manure depends not less on the care which is bestowed on its keeping than on the kind of food the fowls consume. The excretion of birds, on account of their peculiar character, undergoes a rapid change; a large amount of ammonia is soon formed, which reduces materially its manurial value, in case it is allowed to escape. A liberal use of plaster, of kieserite or of good loam is highly recommendable for the absorption of the ammonia. The safest way to secure the full benefit of the droppings is to gather them quite frequently, and to add directly any of the previously-mentioned materials. A sandy soil is of little use as an absorbent.

Fresh Hen Manure.

[Sent on from Townsend, Mass.]

	Per cent.
Moisture at 100° C.,	45.73
Phosphoric acid (6 cents per pound),	0.47
Potassium oxide (4¼ cents per pound),	0.18
Calcium oxide,	0.97
Nitrogen, total (17 cents per pound),	0.79
Insoluble matter, sand, etc.,	39.32
Valuation per 2,000 lbs.,	$3 42

This sample of fresh hen manure came from the same party who sent on the dry sample. It was inferior in quality as compared with the first material; it contained for the same amount of organic matter about twice as much worthless earthy matter. In a dry state, corresponding with the first sample, 8 per cent. of moisture, it would be worth only one-half as much, *i. e.*, about $5 per ton.

Ashes of Chestnut Railroad Ties.

[Sent on from Waltham, Mass.]

	Per cent
Moisture at 100° C.,	6.15
Calcium oxide,	4.71
Magnesium oxide,	1.80
Potassium oxide,	0.19
Phosphoric acid,	1.54
Insoluble mineral matter,	77.83

The material was of a dark brown color, and evidently not the pure ash, for it contained 77.83 per cent. of worthless earthy matter. The ash in the above-described state does not pay carrying any considerable distance; it is worth much less than leached ashes.

Waste Hemlock Tan Bark Ashes.

[Sent on from Peabody, Mass.]

	Per cent.
Moisture at 100° C.,	4.87
Phosphoric acid,	0.13
Calcium oxide,	37.26
Magnesium oxide,	2.98
Potassium oxide,	2.10
Insoluble matter,	24.33

This ash, from a waste product of a tannery, has lost a large percentage of its original potash.

Hard Pine Wood Ashes.

[Sent on from South Lincoln, Mass.]

	Per cent
Moisture at 100° C.,	0.75
Total insoluble matter,	29.90
Insoluble mineral matter,	23.74
Calcium oxide,	24 95
Magnesium oxide,	8.39
Phosphoric acid,	2.24
Potash,	10.16

This material shows an exceptionally high per cent. of potash.

Canada Wood Ashes.

[I., II. Sent on from Concord, Mass. III., IV. Sent on from South Deerfield, Mass.]

	I.	II.	III.	IV.
Moisture at 100° C.,	17.00	18.15	4.90	2.48
Potassium oxide,	4.28	4.80	7.42	6.53
Calcium oxide,	31.31	30.69	42.10	42.98
Magnesium oxide,	2.36	3.71	3.55	3.66
Phosphoric acid,	3.34	3 26	2.00	1.44
Insoluble matter,	15.50	17.35	7.12	4.87

These samples represent the extremes of composition noticed in our section of the State. The use of Canada ashes has of late steadily increased, and the cost gradually declined to 24 to 25 cents per bushel of forty-five to fifty pounds. These are prices by the car-load at Amherst and in its vicinity.

Wood Ashes.

[I. Sent on from South Framingham, Mass. II. Sent on from West Tisbury, Mass. III., IV. Sent on from South Sudbury, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	5 10	17.63	17.43	11.76
Total phosphoric acid,	1.30	1.66	1.70	1.41
Magnesium oxide,	3.24	3.42	2.88	3.12
Calcium oxide,	39.07	34.54	29.87	32.81
Potassium oxide,	5.76	3.67	4.30	5.58
Insoluble matter (before calcination),	9.20	11.08	18.38	16.57
Insoluble matter (after calcination),	7.68	8.86	15.48	13.26

The difference in moisture in the above analyses explains somewhat the difference in potash.

Wood Ashes. (Two samples.)

[Sent on from South Deerfield Farmers' Club.]

	Pounds per Hundred.	
	I.	II.
Moisture at 100° C.,	16.75	11.79
Phosphoric acid,	1.79	1.34
Calcium oxide,	32.28	34.62
Magnesium oxide,	3.48	4.02
Potassium oxide,	1.80	6.68
Insoluble matter,	16.55	9.50

The first article is evidently a partly leached wood ash. The two samples differ mainly in regard to their relative amount of potash. This difference expressed in money value amounts to from 26 to 27 cents per hundred weight of ashes, allowing 5.5 cents per pound of potassium oxide in case of wood ash.

Wood Ashes.

[I., II. Sent on from Somerset, Mass. III. Sent on from Byfield, Mass]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	4.82	2.43	9.98
Phosphoric acid,	3.07	1.45	1.80
Calcium oxide,	34.42	45 09	33.51
Magnesium oxide,	4.09	2.64	3.54
Potassium oxide,	4.56	1.99	1.28
Insoluble matter (before calcination),	18.17	12.57	22.43
Insoluble matter (after calcination),	15.37	7.71	19.15

Nos. II. and III. are evidently leached wood ashes.

Ashes of Cotton Seed Hulls.

[I. Sent on for examination from South Deerfield, Mass. II. Sent on from North Amherst, Mass.]

	Pounds per Hundred.	
	I.	II.
Moisture at 100° C.,	10.95	6.38
Phosphoric acid (6 cents per pound),	6.90	10.69
Calcium oxide,	5.76	13.34
Magnesium oxide,	9 15	Not determined.
Potassium oxide (5½ cents per pound),	25 34	24.16
Insoluble matter,	10.45	10.72
Valuation per 2,000 pounds,	$36 15	$39 41

There is evidently a considerable variation in the composition of this article. Direct communication from a well-informed

Southern source accounts for this fact by stating that more or less seeds are not unfrequently mixed with hulls when burned. An article which represents a high money value, like the above material, ought to be bought only on analysis.

Cotton Seed Hull Ash.

[Sent on from Northampton, Mass]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	7.43	7.77	7.30	8.23
Phosphoric acid (6 cents per pound),	5.21	9.68	9.59	11.19
Magnesium oxide,	10.11	14.48	14.81	16.71
Calcium oxide,	6 71	18.42	12.23	12.43
Potassium oxide (5½ cents per pound),	25.76	17.34	19.15	24.91
Insoluble matter (before calcination),	12.36	11.30	10.88	7.34
Insoluble matter (after calcination),	12.18	6.34	8.86	5.18
Valuation per ton of 2,000 pounds,	$36 78	$30 70	$32 58	$40 83

Cotton Seed Hull Ash.

[Sent on for examination from Northampton, Mass.]

	Per cent.
Moisture at 100° C.,	2.30
Calcium oxide,	11.63
Magnesium oxide,	15.24
Phosphoric acid (6 cents per pound),	13,67
Potassium oxide (5½ cents per pound),	30.82
Insoluble matter,	21.65
Valuation per 2,000 pounds,	$50 30

The percentage of potash found in the above sample is exceptionally high. The same may be said of the phosphoric acid.

Muriate of Potash.

[I. Sent on from Northampton, Mass. II. Sent on from Williamsburg, Mass. III. Sent on from South Deerfield, Mass.]

	Pounds per Hundred.		
	I.	II.	III.
Moisture at 100° C.,	1.02	2.00	4.05
Potassium oxide,	50.09	54.45	45.94
Sodium oxide,	9.94	Not de-	termined.
Magnesium oxide,	0.63	Not de-	termined.
Valuation per 2,000 lbs.,	$42 58	$46 28	$39 05

The large amount of moisture in the last sample explains somewhat the lower percentage of potassium oxide. The principal admixture of salines in this brand of potash compounds consists of common salt, usually from 14 to 18 per cent.

Muriate of Potash.

[I. Sent on from Fall River, Mass. II. Sent on from Amherst, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	0.49	0.27
Potassium oxide (4¼ cents per pound),	50.79	51.82
Sodium oxide,	10.08	9.85
Valuation per 2,000 lbs.,	$43 27	$44 09

Sulphate of Potash.

[Sent on for examination, Amherst, Mass.]

	Per cent.
Moisture at 100° C.,	0.80
Potassium oxide (5½ cents per pound),	47.86
Sodium oxide,	1.68
Sulphuric acid (5½ cents per pound),	45.06
Chlorine,	0.66
Insoluble matter,	0.60
Valuation per ton of 2,000 lbs.,	$52 65

Double Manure Salt.

[Sent on from New York.]

[I. Crystallized double manure salt. II. Commercial double manure salt]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	11.58	6.58
Magnesium oxide,	10.81	11.50
Calcium oxide,	–	2.93
Sodium oxide,	3.16	4.16
Potassium oxide (5½ cents per pound),	22.40	23.28
Sulphuric acid,	39.89	43.43
Chlorine,	0.14	1.08
Insoluble matter,	0.26	1.80
Valuation per 2.000 lbs.,	$24 64	$25 61

The first-named article consisted of large, clear, colorless and well-developed crystals, which, in consequence of a loss of water, turned gradually whitish on exposure to the air. The second one consisted of a yellowish white powder, and represents the article for our markets. Both salines consist essentially of sulphate of potash and sulphate of magnesia, and are remarkably free from chloride (common salt, etc.).

Fish Waste.

[I. Sent on from Boston. II. Sent on from Gloucester. III. Sent on from Marshfield.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	71.11	8.62	40.35
Organic and volatile matter,	–	50.16	73.01
Ash,	–	49.84	26.99
Total phosphoric acid,	0.60	6 99	2.94
Soluble phosphoric acid,	–	0.67	–
Reverted phosphoric acid,	–	2.90	1.06
Insoluble phosphoric acid,	–	3.42	1.88
Nitrogen,	2 21	4.97	5.07
Insoluble matter,	–	0.74	0.17
Valuation per 2,000 lbs.,	$4 58	$23 75	$12 50

The difference in the moisture and in the mechanical condition of the above-stated articles controls largely their market value. Samples I. and III. consisted of large pieces of fish meat with fatty matter; the valuation is based in these cases on that of coarse fish scrap. Sample II. corresponds well with a fair specimen of fish guano.

Dried Fish.

[Sent on from North Hatfield, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	8.07	9.10	9.43
Total phosphoric acid,	5.87	8.78	7.37
Soluble phosphoric acid (8 cents per pound),	0.58	0.48	0.51
Reverted phosphoric acid (7½ cents per pound),	2 34	4.08	3.07
Insoluble phosphoric acid (3 cents per pound),	2.95	4.22	3.79
Nitrogen (17 cents per pound),	7.80	8.20	8.44
Insoluble matter,	3.86	3.00	1.30
Valuation per ton of 2,000 lbs.,	$32 71	$37 29	$36 39

Peruvian Guano.

[Sent on for examination, Taunton, Mass.]

	Per cent.
Moisture at 100° C.,	10.13
Total phosphoric acid,	14.31
Soluble phosphoric acid,	1.66
Reverted phosphoric acid,	4 91
Insoluble phosphoric acid,	7.74
Potassium oxide,	2.16
Nitrogen (total),	7.20
Actual ammonia (equal to 5.43 per cent. nitrogen),	6.60
Organic nitrogen,	1.77
Insoluble matter,	4.66
Valuation per 2,000 lbs.,	$42 62

Apparently an artificial product.

Fish and Potash.

[Sent on for examination from Medfield, Mass.]

	Per cent.
Moisture at 100° C.,	23.58
Total phosphoric acid,	6.26
Soluble phosphoric acid (8 cents per pound),	3.58
Reverted phosphoric acid ($7\frac{1}{2}$ cents per pound),	1.33
Insoluble phosphoric acid (3 cents per pound),	1.35
Potassium oxide ($4\frac{1}{4}$ cents per pound),	3.24
Nitrogen (17 cents per pound),	3.07
Insoluble matter,	1.90
Valuation per 2,000 lbs.,	$21 73

High Grade Superphosphate.

[Sent on from Boston, Mass.]

	Per cent.
Moisture at 100° C.,	5.03
Total phosphoric acid,	25.36
Reverted phosphoric acid,	15.23
Soluble phosphoric acid,	0.25
Insoluble phosphoric acid,	9.88
Sulphuric acid,	0.22
Calcium oxide,	0.70
Oxides of alumina and iron,	24.95
Magnesium oxide,	0.10
Insoluble matter,	18.91
Valuation per ton of 2,000 lbs.,	$29 18

German High Grade Superphosphate.

[I. Sent on from New York City, N. Y., by a Boston manufacturer of fertilizers.
II. Sent on from Boston, Mass.]

	Pounds per Hundred.	
	I.	II.
Moisture at 100° C.,	15.24	7.50
Total phosphoric acid,	45.54	43.24
Soluble phosphoric acid,	41.56	36.62
Reverted phosphoric acid,	3.58	5.67
Insoluble phosphoric acid,	0.40	0.95
Insoluble matter,	5.20	2.50
Valuation per 2,000 lbs.,	$78 47	$67 67

The material serves for the manufacture of high grades of "formula fertilizers." The amount of sulphuric acid present in either sample did not exceed 3.5 per cent. This fact shows that the product is obtained by a different process than our ordinary superphosphates; it is most likely the isolated soluble portion of the latter evaporated after its separation from the insoluble sulphate of lime, etc.

Flamingo Guano.

[Sent on from Worcester, Mass.]

	Per cent.
Moisture at 100° C.,	17.20
Total phosphoric acid,	16.16
Soluble phosphoric acid,	0.48
Reverted phosphoric acid,	5.22
Insoluble phosphoric acid,	10.46
Potassium oxide,	0.31
Nitrogen,	0.80
Insoluble matter,	2.95
Valuation per 2,000 lbs.,	$17 86

Dissolved Boneblack.

[Sent on from South Deerfield, Mass.]

	Per cent.
Moisture at 100 C.,	20.43
Total phosphoric acid,	16.14
Soluble phosphoric acid,	15.81
Reverted phosphoric acid,	0.18
Insoluble phosphoric acid,	0.15
Insoluble matter,	0 94
Valuation per 2,000 lbs.,	$25 64

The article is a fair representative of its kind; its moisture is rather more than usual.

Compound Fertilizers.

[I. and II. Sent on from Methuen, Mass. III. Sent on from Groton, Mass. IV. Sent on from Lowell, Mass.]

	Per Cent.			
	I.	II.	III.	IV.
Moisture at 100° C.,	9.03	17.24	23.00	10.40
Organic and volatile matter,	34.28	51.04	55.30	48.76
Ash,	65.72	48.96	44.70	51.24
Total phosphoric acid,	7.96	6.06	12.67	17.88
Soluble phosphoric acid,	0.16	3.97	1.41	4.54
Reverted phosphoric acid,	2.52	0.93	7.36	9.78
Insoluble phosphoric acid,	5.28	1.16	3.90	3.56
Potassium oxide,	5.92	1.02	1.03	0.10
Nitrogen,	1.30	1.92	1.73	3.03
Insoluble and silicious matter,	4.16	22.36	3 70	1.88
Valuation per ton of 2,000 lbs.,	$16 66	$15 85	$22 42	$34 37

Compound Fertilizers.

[Sent on for examination from South Hadley Falls, Mass.]

	Per Cent.		
	I.	II.	III.
Moisture at 100° C.,	5.24	8.08	12.45
Total phosphoric acid,	15.07	10.44	6.62
Soluble phosphoric acid,	0.29	2.88	0.58
Reverted phosphoric acid,	3.57	4.00	2.53
Insoluble phosphoric acid,	11.21	3.56	3.51
Nitrogen,	5.77	4.03	4.17
Potassium oxide,	–	7.64	6.45
Insoluble matter,	1.23	1.06	5.00
Valuation per ton of 2,000 lbs.,	$32 17	$32 94	$26 50

Compound Fertilizers — Concluded.

[IV. Sent on from Amesbury, Mass. V. Sent on from Newburyport, Mass.]

	Per Cent.	
	IV.	V.
Moisture at 100° C.,	9.21	6.43
Total phosphoric acid,	21.10	20.89
Soluble phosphoric acid,	0.77	0.70
Reverted phosphoric acid,	7.82	7.07
Insoluble phosphoric acid,	12.51	13.12
Nitrogen,	3.03	2.75
Potassium oxide,	-	-
Insoluble matter,	1.02	2.27
Valuation per 2,000 lbs.,	$32 14	$30 73

Steamed Bone.

[I. Sent on from Monson (fine ground). II. Sent on from Worcester (contained many coarse pieces).]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	5.70	5.06
Organic and volatile matter,	40.68	33.68
Ash,	59.32	66.32
Total phosphoric acid,	21.99	26.17
Reverted phosphoric acid,	3.23	6.56
Insoluble phosphoric acid,	18.76	19.61
Nitrogen,	3.53	3.17
Insoluble matter,	2.10	2.61
Valuation per 2,000 lbs.,	$34 20	$33 77

The difference in the mechanical condition of the steamed bones causes the variation in the valuation of the phosphoric acid and of the nitrogen. The first sample was of a good average fineness; the second consisted largely of coarse yet porous pieces; the phosphoric acid in the latter is valued at four cents per pound, and the nitrogen thirteen cents, whilst five and fifteen respectively are allowed in case of the former.

Ground Bone.

[I. Fine-ground bone sent on from Concord, Mass. II. Fine-ground bone compost sent on from Concord, Mass.]

	Per Cent.	
	I.	II.
Moisture at 100° C.,	4.78	21.73
Organic and volatile matter,	25.48	38.76
Ash,	74.52	61.24
Total phosphoric acid,	29.83	9.81
Reverted phosphoric acid,	9 22	0.88
Insoluble phosphoric acid,	20.61	8.93
Potassium oxide,	-	2.95
Nitrogen,	2.03	0.50
Insoluble matter,	0.30	8.00
Valuation per ton of 2,000 lbs.,	$34 39	$14 26

The above samples of rendered, ground bones, and of a bone compost prepared from the former by mixing with wood ashes, were sent on to ascertain the exact changes which the material had suffered after a few months' keeping. The analyses show less *soluble* phosphoric acid, and also less nitrogen for the same amount of phosphoric acid in the bone compost, when compared with the original bones.

The operation of composting bones with wood ashes proved in the present case a decided loss, for more than one-fourth of the original nitrogen had been lost in the form of ammonia. A sample of the material, sent on for examination,

gave evidence of the gradual escape of ammonia when kept for a few days in a well-closed bottle.

To derive benefit from composting bones with wood ashes requires a careful protection of the mixture against the escape of ammonia, which is invariably formed in the course of time. The mixture ought to be covered at once with a layer of good loam, from six to eight inches in thickness. In addition to this, it is well to scatter some gypsum (plaster) or ground kieserite (crude sulphate of magnesia) over the entire compost heap. The practice of mixing the ground bone with from three to four times its bulk of good soil, moistening the mixture thoroughly with liquid manure, and subsequently covering up the entire mass in a similar way with earth and gypsum or kieserite, also deserves recommendation.

Bone Soup.

[Sent on from Lynn, Mass.]

	Per cent.
Moisture at 100° C.,	82.92
Dry matter,	17.08
Nitrogen,	1.26
Ash constituents,	7 07

The liquid was obtained in rendering bones. Its ash constituents consist mainly of common salt with a small percentage of bone phosphate, and its agricultural value depends mainly on the nitrogen present. Allowing fifteen cents per pound of that element, one ton of the soup represents a value of $3.78. It ought to be economized.

Dried Blood.

[Sent on for examination.]

	Per cent.
Moisture at 100° C ,	11.99
Nitrogen (17 cents per pound)	13.55
Valuation per 2,000 lbs.,	$46 07

Ammonium Sulphate.

[Sent on from Amherst, Mass.]

	Per cent.
Moisture at 100° C.,	0.13
Nitrogen 20.88 per cent.; equal to ammonia,	25.35
Sulphuric acid,	59.74

Miscellaneous Analyses.

Examinations for Metallic Poisons.

Four samples of material have been sent for investigation. Three examinations were made at the request of the Cattle Commission of the State. The material sent consisted in these cases of the stomach and some of the adjoining organs with their contents, besides the liver, bile and bladder of three cows. Two of these specimens came from Ashfield and one from Enfield, Mass. In the first case — from Ashfield — there was found a considerable quantity of copper, apparently due to presence of fine scraps of brass among the contents of the stomach; in the others no metallic poison could be detected. The fourth case came from Amherst, Mass. The material for examination consisted of the stomachs, with contents, of chickens. A considerable quantity of arsenic acid was proved to be present.

Analyses of Maple Sap for Mineral Constituents.

[Sent on from Goshen, Mass. I. Sample from an old tree, sp. gr., 1.015, at 23° C. II. Sample from a young tree, sp. gr., 1.010, at 23° C.]

	Parts per Thousand.	
	I.	II.
Calcium oxide,	0.114	0.108
Magnesium oxide,	0.067	0.075
Silicic acid,	0.029	0.026
Chlorides of alkalies,	0.180	0.200

The examination was made to ascertain the relative amount of lime present in both saps. The difference is but slight, as may be seen from the above analyses.

Analyses of Well Water, sent on for Examination.

[Parts per Million.]

	Actual Ammonia.	Albuminoid Ammonia.	Chlorine.	Solids at 100° C.	Solids at red heat.	Hardness (Clark's degree).
I.,	.32	.36	38.00	280.00	95.00	–
II.,	.09	.14	18.50	140.00	80.00	4.03
III.,	.14	.25	9.00	Not deter-	mined.	–
IV.,	.04	.17	56.00	Not deter-	mined.	–
V.,	.12	.16	12.00	.098	.038	–
VI.,	.05	.12	16.00	.126	.036	4.71
VII.,	.03	.08	3.00	.046	.034	2.47
VIII.,	.04	.06	5.00	.062	.044	4.03
IX.,	.12	.09	4.00	.134	.100	7.43
X.,	.04	.06	3.00	.136	.100	6.71
XI.,	.02	.08	5.00	.064	.039	–
XII.,	.014	.00	.06	–	–	2.90
XIII.,	.01	.08	76.00	.280	.082	5.65
XIV.,	.004	.064	13 00	.092	.062	2.73
XV.,	.006	.056	14.50	.100	.04	2.28
XVI.,	.04	.07	4.00	.082	.052	4.16
XVII.,	.02	.093	22.00	.164	.06	4.71
XVIII.,	–	.102	7.00	.104	.052	5.71
XIX.,	.04	.07	4.00	.082	.052	4.16
XX.,	.02	.093	22.00	.164	.06	4.71
XXI.,	–	.102	7.00	.104	.052	5.71

The above-stated results of analyses of drinking water are obtained from samples sent on for that purpose from various parts of the State. In most instances these requests are accompanied by a specified instruction regarding the object of the party interested, — a circumstance which renders the task of the chemist, comparatively speaking, an easy one.

A satisfactory supply of good drinking water on a farm depends, in a controlling degree, on a judicious selection of the location of the well designed for the use of the family and for the live stock, and on the personal attention bestowed, from time to time, on the condition of the latter and its surroundings. Good wells are liable to change for the worse at any time, on account of circumstances too numerous to state in this connection. To ascertain from time to time the exact condition of the well which supplies the wants of the family and of the live stock, is a task which no farmer can for any length of time discard, without incurring a serious risk in health and prosperity. The subject receives quite frequently but little attention, on account of the fact that the harmful qualities which an apparently good water may contain are disguised beyond recognition by the unaided senses. Certain delicate chemical tests, aided at times by microscopical observations, are, in the majority of cases, the only reliable means, in our present state of scientific inquiry, by which desirable information regarding the true character of a drinking water can be obtained.

These tests, it must be acknowledged, although of the greatest importance from a general standpoint, have their limitations. They readily indicate the presence of organic matters, but give no unfailing decision regarding their origin, — whether animal or vegetable, — leaving thus, quite frequently, the degree of their harmfulness quite undecided. However, the chemical analysis may be depended upon for all practical purposes, as revealing the presence of objectionable qualities in the water.

The harmful substances found in drinking water are of two classes, — mineral and organic. Few natural waters are entirely free from mineral matters; nearly all contain small quantities of lime, soda, magnesia and iron, — substances which may be considered harmless in that case. Larger quantities of these elements, however, render the water objectionable for drinking, and also more or less unfit for various applications, as washing and cooking, feeding of steam apparatus, etc.

Foremost among the dangerous mineral substances which have been found in drinking water is lead. Its presence is usually due to the use of lead-pipes for conducting the water from the well to the pump and elsewhere. Lead is a treacherous and dangerous poison. Not a trace should be tolerated in

drinking water. The use of lead pipes for conducting the latter for any of the above-named purposes should be decidedly discouraged.

The most frequent source of danger comes, evidently, from the presence of organic matter, indicating contamination by decaying animal and vegetable substances. Wells are not infrequently found polluted by the gases and liquids emanating from sinks, privies, cesspools or barnyards, when apparent conditions would seem to render it impossible.

Attention has already been called to this important matter in a previous report; for one of the first requirements of success on a farm consists in an ample supply of good water. Cities and towns usually have their organizations for the supply of water, and they exact certain guarantees regarding the quality furnished for their use. The farmer, living as a rule more isolated, is in this respect largely left to his own counsel. Much has been written on this subject; yet, as the necessity for constant warning still remains, a restatement of certain facts cannot fail to assist in keeping the subject here under consideration prominently before all parties concerned. The above-recorded analyses have been made according to Wancklyn's process, familiar to chemists, and are directed toward the indication of the presence of chlorine, free and albuminoid ammonia, and the poisonous metals. (For a more detailed description of this method see Water Analysis, by J. A. Wancklyn and E. T. Chapman.)

The hardness was determined by Frankland's method. (See Frankland's Water Analyses, page 29.)

The presence of chlorine indicates contamination from sinks, privies or sewers, since it occurs abundantly in urinary secretions; but it may be derived from other and less harmful sources, as saline waters, which the test fails to indicate. One conclusion is, however, safe, — a water which contains no chlorine is uncontaminated by sewerage. "Free" and "albuminoid" ammonia are forms in which organic matter is recognized. Ammonia existing as such in water is termed "free." This being expelled by distillation, the nitrogen-containing organic matter remaining is reduced to ammonia by chemical agencies, and this secondary product is called "albuminoid ammonia."

The per cent. of total solids is obtained by evaporating a

known quantity of the sample to dryness and weighing the residue.

Hardness, a rather arbitrary term, signifies that quality of water which prevents the ready formation of lather with soap. It is usually due to the presence of salts of lime or magnesia, which decompose the soap, forming new insoluble compounds. As long as these reactions occur no lather will be formed, consequently the quantity of a standard soap consumed before a permanent lather is obtained indicates the amount of earthy salts contained in the sample, or its relative degree of hardness. Frankland's scale has been changed to Clark's, the latter being a more popular one. Ten degrees of Frankland's scale are equivalent to seven of Clark's.

Mr. Wancklyn's interpretation of the results of his mode of investigation are as follows: —

1. Chlorine alone does not necessarily indicate the presence of filthy water.

2. Free and albuminoid ammonia in water without chlorine indicates a vegetable source of contamination.

3. More than five grains per gallon of chlorine, accompanied by more than 0.08 parts per million of free ammonia and more than one-tenth part per million of albuminoid ammonia, is a clear indication that the water is contaminated with sewage, decaying animal matter, urine, etc., and should be condemned.

4. Eight hundredths part per million of free ammonia and one-tenth part per million of albuminoid ammonia render a water very suspicious, even without much chlorine.

5. Albuminoid ammonia over 0.15 parts per million ought to absolutely condemn the water which contains it.

6. The total solids found in the water should not exceed forty grains per gallon.

An examination of the above results of analyses shows that Nos. 4, 6 and 13 are of a suspicious character, and that Nos. 1, 2, 3, 5, 9 and 12 ought to be condemned.

Parties sending on water for an analysis ought to be very careful to use clean vessels, clean stoppers, etc. The sample should be sent on without delay after collecting. One gallon is desirable for the analysis.

METEOROLOGY.

The meteorological observations during the year 1886 have been carried out on the same general plan as was followed in 1885. The system is essentially the same as that recommended to voluntary observers of the U. S. Signal Service. (See Third Annual Report.) The relative humidity has, however, been obtained only during the growing season; it was found impracticable with our present facilities to run the "wet bulb" thermometer during the winter months. Our monthly records of observations have been forwarded regularly at the earliest possible date to the chief Signal Office during the entire year.

The importance of weather observations to the Station itself, in connection with its field experiments, cannot be overestimated. The summaries, as they appear from time to time in our bulletins and annual reports, are not without some interest to the farmers throughout the State. For the benefit of the farmers in our vicinity a more complete system of flag signals to indicate the expected changes in the weather will be introduced during the coming season.

The more conspicuous local meteorological phenomena of the past year (1886) consist in the early opening of the spring, the even distribution of the rainfall throughout the growing season, the absence of severe early or late frosts, and the abundant rainfall during the autumn months. Only once during the summer, the first half of July, did the drought become of sufficient severity to injure vegetation, and then but slightly. The first important snowfall of the year occurred January 9 (seven inches). Good sleighing was noticeable only at intervals throughout the remainder of the winter. The effect of two "ice storms," so injurious to orchards and shade trees throughout the central part of the State, was not felt here. The heavy rainfall of February 10 to February 14 did no material damage. The total snowfall for the months of January, February and March was 23.0 inches; on April 3, 0.5 inches of snow fell; from the 5th to the 7th occurred a rain and snow storm of con-

siderable severity. The latest damaging frost was on April 30, and the last of the season occurred May 18, doing no material harm. The season was, at the beginning of May, judging from the state of the vegetation, at least two weeks in advance of the general average year.

The following table gives the temperatures and rainfall, arranged in fortnightly periods, for the spring and fall months: —

	April, Last 15 Days.	May, First 15 Days.	May, Last 16 Days.	June, First 15 Days.	Aug., Last 15 Days.	Sept., First 15 Days.	Sept., Last 15 Days.	Oct., First 15 Days.
Precipitation.								
Average for 48 years, .	1.73 in.	2 06 in.	1.86 in.	1.81 in.	2.02 in.	1.46 in.	1.84 in.	1.89 in.
For 1885, . . .	1.78 in.	1.01 in.	2.07 in.	1.61 in.	3.45 in.	0.69 in.	1.01 in.	1.68 in.
For 1886, . . .	0.10 in.	2.73 in.	0.37 in.	0.88 in.	1.63 in.	0.51 in.	4.97 in.	0.10 in.
Temperature.								
Average for 48 years, .	48.6°	57.0°	60.4°	64.9°	67.5°	64.3°	58.0°	52.4°
For 1885, . . .	51.6°	46.9°	61.1°	60.7°	63.2°	59.9°	52.9°	49.1°
For 1886, . . .	57.7°	55.7°	58.5°	61.8°	66.0°	62.9°	56.1°	52.2°

The first frost of the fall occurred September 2; but little damage was done. Other light frosts followed September 14, 21 and 22. The first killing frost came October 3; on the 17th the ground was frozen to the depth of one inch, and the minimum thermometer registered 17° F. The first snow of the winter of 1886 and 1887 came November 13, amounting to one inch; during December there was a fall of 16 inches, making a total of 40.5 inches for the entire year.

The prevailing direction of the wind, as taken from the monthly summaries, gives 29.2 per cent. from the northwest, 33.3 per cent. from the south, 20.9 per cent. from the north, 8.3 per cent. from the southwest, and 8.3 per cent. from the west.

Rain or snow fell in measurable quantities on 122 days. The greatest number of such days in any one month was sixteen, in December, and the fewest was six, in April.

The "clear" days, *i. e.*, those on which the sky was less than four-tenths overcast at each observation, numbered 104, of which July had the greatest, thirteen; and April the fewest, four.

The "cloudy days," or those on which the sky was more than seven-tenths obscured at each observation, were eighty-seven in number, of which January, March and December had the greatest, eleven each; and August fewest, two. The balance of the year, 174 days, was "fair," with the sky from four to seven-tenths obscured at each observation.

The highest temperature recorded throughout the year was 95.0°, occurring July 6; and the lowest — 22.0°, January 13 and 14, giving as the absolute range of temperature for the year 117.0°.

Miscellaneous Phenomena. — Dates.

	Frost.	Snow.	Rain.	Thunder-storms.	Solar Halos.	Lunar Halos.
January, . .	2, 14, 15, 16.	9, 18, 19, 24, 30.	4, 5, 18, 19, 21, 27, 28, 29, 30	–	11, 13, 31.	20.
February, . .	1, 15, 17, 18, 19.	21, 22, 25, 26.	11, 12, 13, 15, 19, 25, 26.	–	4, 6.	18.
March, . . .	6, 7, 17, 18.	8, 9, 12, 19, 21, 22.	13, 21, 27, 29.	–	–	–
April, . . .	2, 9, 30.	3.	5, 6, 7, 13, 19, 24, 27.	–	–	–
May, . . .	1, 18.	–	4, 5, 7, 8, 10, 11, 13, 15, 16, 20, 25.	20.	19.	–
June, . . .	–	–	2, 3, 13, 14, 15, 16, 17, 23, 24, 25, 26.	25, 26.	1.	20.
July, . . .	–	–	10, 14, 15, 16, 17, 18, 21, 26, 27, 29.	18, 27, 29.	–	–
August, . .	–	–	1, 2, 5, 7, 14, 16, 30, 31.	30.	–	–
September, . .	2, 14, 21, 22.	–	12, 13, 15, 16, 17, 19, 22, 23, 25, 26, 27, 28, 29.	17, 28.	–	–
October, . .	2, 3, 17, 22, 24.	–	14, 15, 17, 18, 26, 27, 28, 29, 30, 31.	–	–	–
November, . .	5, 8, 9, 16, 26, 27, 28, 29.	13, 25.	6, 7, 10, 12, 13, 17, 18, 22, 23, 25, 30.	–	4, 16.	–
December, . .	10, 21, 23.	5, 7, 13, 15, 16, 17, 18, 23, 24, 25, 26, 27, 29, 30, 31.	12, 13, 17, 18, 31.	–	4.	4, 10.

Summary of Meteorological Observations, 1886.

	Temperature. Degrees Fahrenheit.											Relative Humidity. Per ct.				Precipitation. Inches.	
	7 A. M.	2 P. M.	9 P. M.	Mean.	Maxi-mum.	Mini-mum.	Range.	Absolute Maxi-mum.	Date.	Absolute Mini-mum.	Date.	7 A. M.	2 P. M.	9 P. M.	Mean.	Depth of Water.	Date of Greatest Fall.
January,	17.7	26.0	21.9	21.9	31.2	16.5	14.7	56.0	5th	—22	13th, 14th	-	-	-	-	5.39	27th to 30th
February,	17.8	27.0	23.8	23.1	30.9	13.8	17.1	52.0	15th	—11	5th	-	-	-	-	3.94	11th to 13th
March,	28.8	38.5	33.3	33.5	40.4	23.9	16.5	61.0	31st	—1	1st	-	-	-	-	3.31	19th
April,	43.5	56.5	50.9	50.4	61.3	35.6	26.0	83.0	20th	20.0	11th	89.0	74.8	80.2	81.4	1.73	5th to 7th
May,	50.3	66.0	56.3	57.3	70.6	45.3	25.3	82.0	23d	29.0	1st	93.9	72.4	87.5	84.6	3.10	7th to 8th
June,	58.5	70.4	61.9	63.2	72.9	48.9	24.0	82.0	21st	40.0	1st	94.0	71.5	84.2	83.2	2.33	23d to 25th
July,	63.3	78.2	70.0	68.8	80.8	55.2	25.6	95.0	6th	40.1	12th	90.7	59.6	81.7	77.4	3.82	14th to 17th
August,	60.4	77.1	63.8	66.3	79.0	53.4	25.6	90.0	27th	38.0	23d	91.2	59.7	81.2	77.4	2.60	30th to 31st
September,	53.6	69.3	57.5	59.5	70.4	46.7	23.7	83.8	9th	31.6	21st	93.6	58.7	87.3	70.4	5.48	27th to 29th
October,	41.9	58.1	47.8	48.9	59.0	37.4	11.6	77.9	9th	17.0	17th	90.4	62.6	79.4	77.3	2.97	26th to 30th
November,	34.4	44.5	37.1	38.3	47.6	28.5	19.1	65.5	2d	15.9	28th	-	-	-	-	5.26	17th to 18th
December,	19.3	27.1	22.8	23.0	30.3	13.7	16.6	49.0	11th	0.8	30th	-	-	-	-	3.61	30th to 31st
Sums and means,	40.8	53.2	45.6	46.2	56.2	34.9	20.5	73.1	-	16.5	-	*91.8	*65.6	*83.1	*78.8	43.54	-

* Means of 7 months.

Record

Of the Average Temperature taken from Weather Records at Amherst, Mass., for three consecutive months, during the summer and winter, beginning with the year 1836.

December, January, February.		June, July, August.	
1836-37, . . .	25.396° F.	1837, . . .	69.130° F.
1837-38, . . .	26.386°	1838, . . .	69.550°
1838-39, . . .	25.950°	1839, . . .	70.180°
1839-40, . . .	20.626°	1840, . . .	68.770°
1840-41, . . .	23.146°	1841, . . .	69.230°
1841-42, . . .	28.516°	1842, . . .	68.210°
1842-43, . . .	23.460°	1843, . . .	67.950°
1843-44, . . .	21.320	1844, . . .	67.260°
1844-45, . . .	25.550°	1845, . . .	70.120°
1845-46, . . .	22.140°	1846, . . .	68.406°
1846-47, . . .	25.176°	1847, . . .	68.806°
1847-48, . . .	28.966°	1848, . . .	69.210°
1848-49, . . .	23.026°	1849, . . .	69.210°
1849-50, . . .	27.570°	1850, . . .	68.820°
1850-51, . . .	25.040°	1851, . . .	66.640°
1851-52, . . .	21.620°	1852, . . .	66.830°
1852-53, . . .	27.940°	1853, . . .	67.846°
1853-54, . . .	23.670°	1854, . . .	69.856°
1854-55, . . .	23.126°	1855, . . .	67.146°
1855-56, . . .	20.820°	1856, . . .	69.225°
1856-57, . . .	22.720°	1857, . . .	67.240°
1857-58, . . .	26.956°	1858, . . .	67.930°
1858-59, . . .	24.746°	1859, . . .	65.650°
1859-60, . . .	24.790°	1860, . . .	66.540°
1860-61, . . .	24.510°	1861, . . .	66.870°
1861-62, . . .	24.470°	1862, . . .	66.490°
1862-63, . . .	27.640°	1863, . . .	66.656°
1863-64, . . .	26.060°	1864, . . .	69.336°
1864-65, . . .	21.310°	1865, . . .	68.946
1865-66, . . .	25.676°	1866, . . .	67.400°
1866-67, . . .	25.276°	1867, . . .	67.920°
1867-68, . . .	20.350°	1868, . . .	69.700°

Record of Temperature, etc. — Concluded.

December, January, February.		June, July, August.	
1868-69, . . .	26.290° F.	1869, . . .	66.890° F.
1869-70, . . .	27.866°	1870, . . .	71.700°
1870-71, . . .	26.666°	1871, . . .	67.810°
1871-72, . . .	24.630°	1872, . . .	70.790°
1872-73, . . .	21.350°	1873, . . .	68.596°
1873-74, . . .	27.286°	1874, . . .	66.306°
1874-75, . . .	21.180°	1875, . . .	68.026°
1875-76, . . .	28.156°	1876, . . .	71.780°
1876-77, . . .	23.510°	1877, . . .	70.080°
1877-78, . . .	28.506°	1878, . . .	68.896°
1878-79, . . .	24.290°	1879, . . .	68.150°
1879-80, . . .	30.506°	1880, . . .	69.286°
1880-81, . . .	21.856°	1881, . . .	67.966°
1881-82, . . .	29.256°	1882, . . .	69.866°
1882-83, . . .	24.220°	1883, . . .	68.840°
1883-84, . . .	26.506°	1884, . . .	68.960°
1884-85, . . .	22.630°	1885, . . .	66.740°
1885-86, . . .	24.846°	1886, . . .	66.100°

Summary

Of Average Temperature from 1836 to 1862 (25 years).

December, January, February.	June, July, August.
24.53° F.	68.26° F.

Summary

Of Average Temperature from 1862 to 1887 (25 years).

December, January, February.	June, July, August.
25.21° F.	68.53° F.

A careful study of the above tables cannot fail to show that the average temperature of the three leading months during summer and winter seasons has not materially changed during the last fifty years,— a fact not generally conceded.

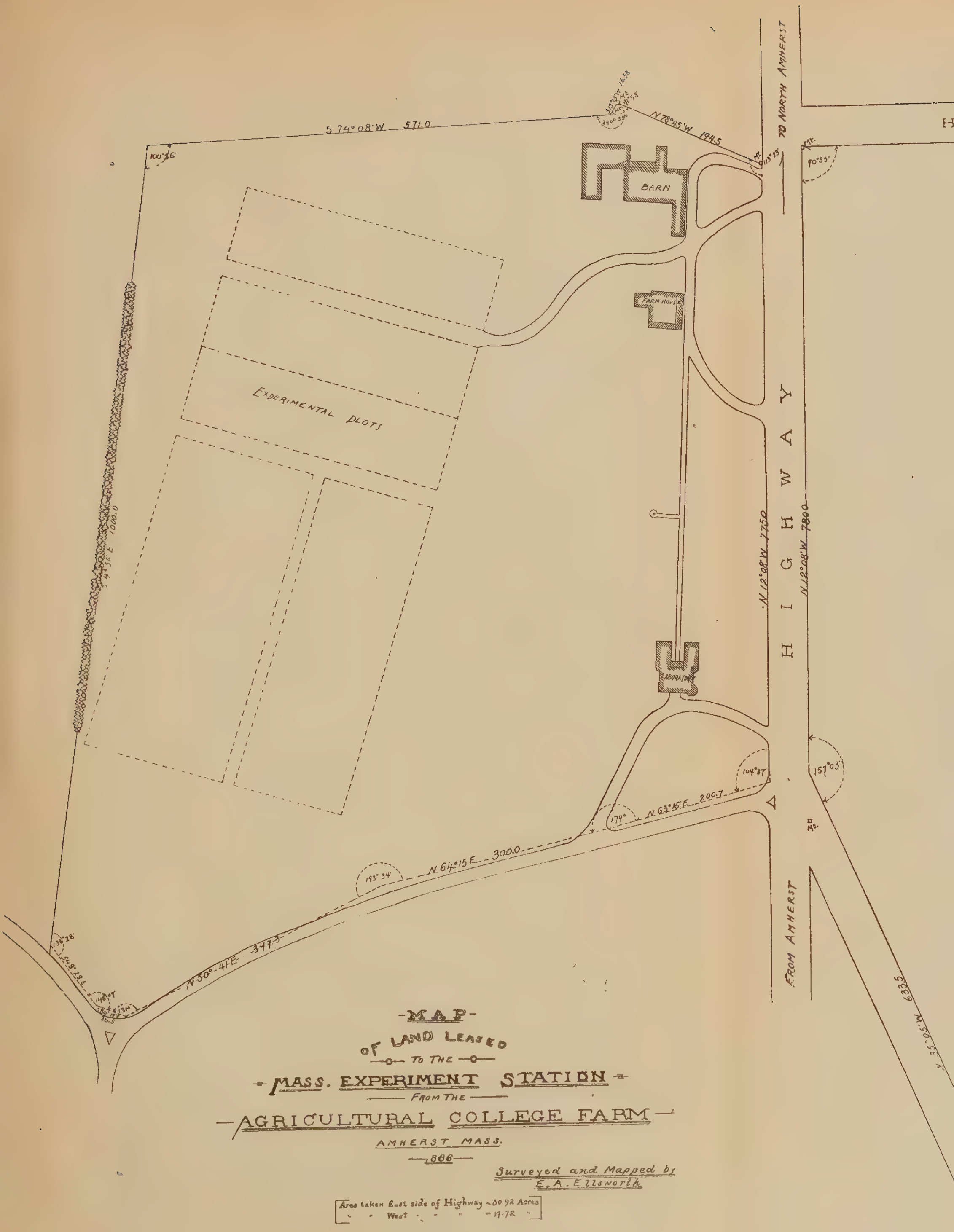
C. A. GOESSMANN,
Director.

JAMES P. LYNDE, *Treasurer, in Account with* MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION.

1886.		*Receipts.*		1886.	*Expenditures.*	
Jan.	1,	Cash in Bank,	$840 79		Salaries,	$3,149 75
	2,	State Treasurer,	2,500 00		Laboratory Supplies,	975 76
	12,	C. A. Goessmann, Director,	281 79		Printing and Postage,	591 86
April	3,	State Treasurer,	2,500 00		Office Expenses,	171 97
	13,	C. A. Goessmann, Director,	61 55		Farmer and Farm Labor,	1,548 36
July	6,	State Treasurer,	2,500 00		Farm Supplies,	812 16
	13,	C. A. Goessmann, Director,	59 01		Stock and Feed,	450 86
Oct.	1,	State Treasurer,	2,500 00		Miscellaneous Expenses,	388 93
					Fitting up Buildings,	2,617 35
					Expenses Board of Control,	135 15
					Cash in Bank Jan. 1, 1887,	400 99
			$11,243 14			$11,243 14

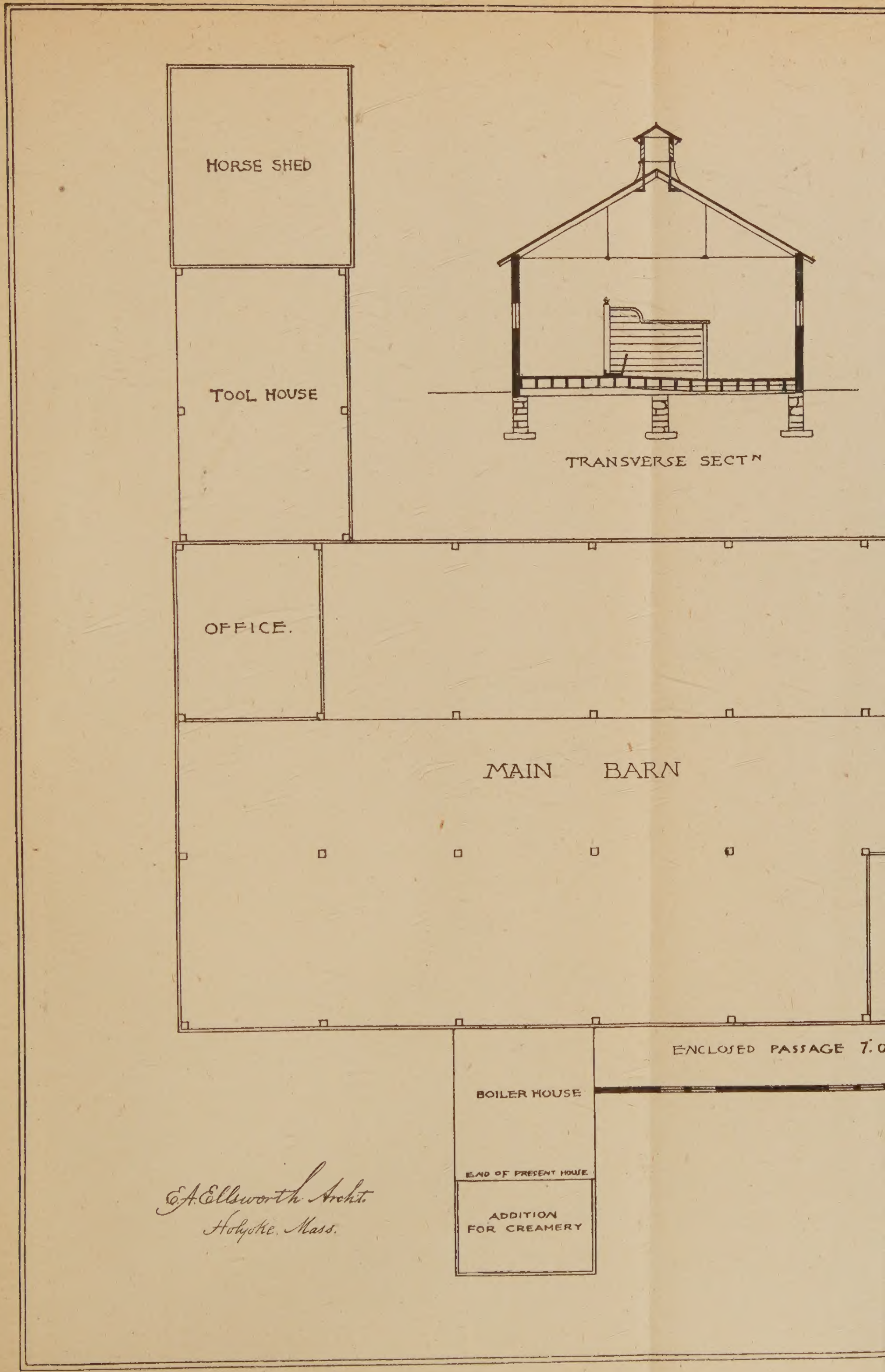
Examined, compared with the vouchers, and found correct.

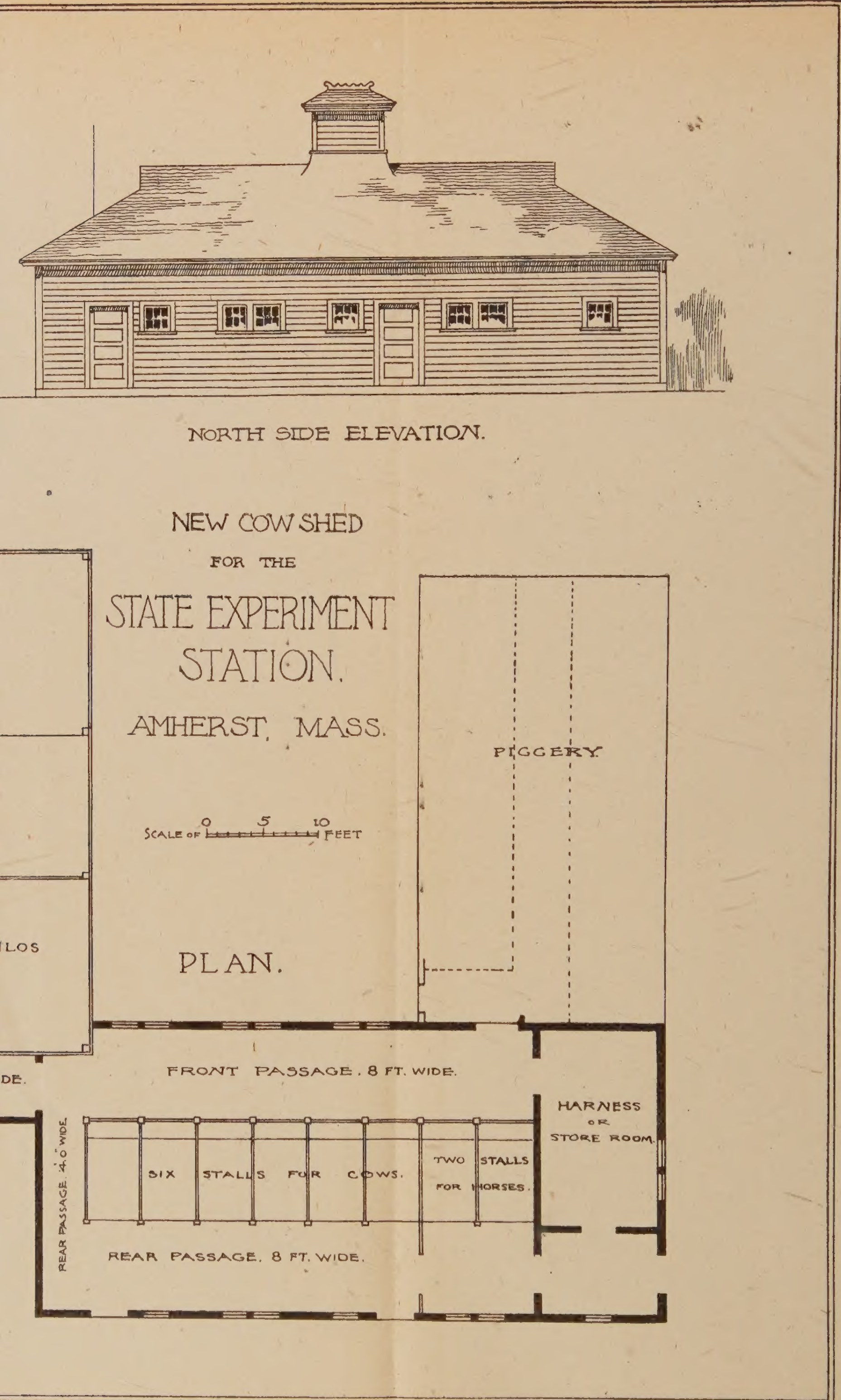
ALVAN BARRUS,
Auditor of the Board of Control.



MAP
OF LAND LEASED
TO THE
MASS. EXPERIMENT STATION
FROM THE
AGRICULTURAL COLLEGE FARM
AMHERST MASS.
1886
Surveyed and Mapped by
E. A. Ellsworth
Area taken East side of Highway 30.92 Acres
" " West " " " 17.72 "
TO NORTH AMHERST
FROM AMHERST
HIGHWAY
BARN
FARM HOUSE
LABORATORY
EXPERIMENTAL PLOTS
S 74°08' W 571.0
N 78°45' W 194.5
N 12°08' W 775.0
N 12°08' W 780.0
N 64°15 E 300.0
N 63°15' E 200.7
N 30° 41' E 347.3
N 35°05' W 633.5

H W A Y
N 75°44'E 382.5
N 76°36' E 221.0
181°13'
180°08'
WOOD LAND
S 16°03' W 1200.0
197°30'
S 11°47' E 237.0
S 73°13' W 150.0
176°08'
S 77° 05' W 486.5
MAGNETIC MERIDIAN
N
W
E


HORSE SHED
TOOL HOUSE
TRANSVERSE SECT^N
OFFICE.
MAIN BARN
ENCLOSED PASSAGE 7.0
BOILER HOUSE
END OF PRESENT HOUSE
ADDITION FOR CREAMERY
E.A. Ellsworth Archt.
Holyoke, Mass.


NORTH SIDE ELEVATION.
NEW COW SHED
FOR THE
STATE EXPERIMENT STATION.
AMHERST, MASS.
SCALE OF 0 5 10 FEET
PLAN.
PIGGERY.
LOS
DE.
FRONT PASSAGE. 8 FT. WIDE.
HARNESS OR STORE ROOM.
REAR PASSAGE. 4.0" WIDE.
SIX STALLS FOR COWS.
TWO STALLS FOR HORSES.
REAR PASSAGE. 8 FT. WIDE.